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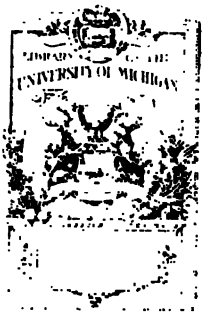

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THE AUTHOR

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1888.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1890.

LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 3, 1889.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences during the past year.

Very respectfully,

O. C. MARSH,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

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REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

The National Academy of Sciences was established by act of Congress in March, 1863, with power to frame its own constitution, select its own members, and provide in other respects for its continuance and successful operation.

The object of the Academy is to advance science, and especially to investigate, examine, experiment, and report on any subject of science or art whenever called upon by any department of the Government.

The Academy contains at present about one hundred members, and these have all been selected for their original researches in science. They represent within their ranks nearly every department of knowledge, and their services, in accordance with the charter of the Academy, are always at the disposal of the Government, without compensation.

SESSIONS OF THE NATIONAL ACADEMY.

During the past year, the Academy has held three sessions. The first was the regular annual meeting held in Washington, D. C., April 17 to 20, 1888; the second was a scientific session, in New Haven, Conn., November 13 to 15, 1888; and the third was a special session in New Haven, November 14, 1888.

STATED SESSION.

HELD IN WASHINGTON CITY, APRIL 17 TO 20, 1888.

The Washington session was held in the National Museum, the president, Prof. O. C. Marsh, presiding.

The following members were present during the session:

Abbe.	Gibbs, W.	Langley.	Oliver.
Abbot.	Gilbert.	Marsh.	Peters.
Billings.	Gill.	Mayer.	Pickering.
Bowditch.	Gould.	Meigs.	Powell.
Brewer.	Hague.	Mendenhall.	Putnam.
Brooks.	Hall, A.	Mitchell, H.	Remsen.
Brush.	Hilgard, J. E.	Morse.	Rowland.
Coffin.	Hill, G. W.	Newberry.	Schott.
Comstock.	Hunt.	Newcomb.	Wright.
Cope.	Hyatt.	Newton, H. A.	

At this session the following papers were read and discussed:

1. OLIVER, J. E.: The Rotation of the Sun.
2. HUNT, T. STERRY: The Foundations of Chemistry.
3. MENDENHALL, T. C.: On an Improved Form of Quadrant Electrometer, with remarks upon its use.
4. COPE, E. D.: On the Vertebrate Fauna of the Puerco Series. Discussed by Messrs. Powell and Gill.
5. BOWDITCH, H. P.: Reinforcement and Inhibition.
6. BELL, A. GRAHAM: On Apparent Elasticity produced in an Apparatus by the Pressure of the Atmosphere; and the Bearing of the Phenomenon upon the Hypothesis of Potential Energy. Discussed by Messrs. Newcomb, Powell, G. W. Hill, and Abbe.
7. NEWTON, H. A.: The Orbits of Aerolites. Discussed by Messrs. Rowland and Peters.
8. PICKERING, E. C.: A Large Photographic Telescope. Discussed by Messrs. Peters, Oliver, Rowland, and Wright.
9. SEDGWICK, W. T., and TUCKER, G. R.; presented by J. S. Billings: A New Method for the Biological Examination of Air, with a description of an Aerobioscope. Discussed by Mr. Billings.
10. GIBBS, WOLCOTT, and HARE, HOBART AMORY: Preliminary Notice of the Object, Methods, and Results of a Systematic Study of the Action of Definitely Related Chemical Compounds upon Animals. Discussed by Mr. Bowditch.
11. COPE, E. D.: On the Auditory Bones of the Batrachia.
12. STONE, ORMOND; presented by S. Newcomb: The Orbit of Hyperion.
13. EMERSON, B. K.; presented by J. W. Powell: Map of Connecticut River Region in Massachusetts.
14. HYATT, A.: Parallel Series in the Evolution of Cephalopoda.
15. HYATT, A.: Evolution of Cephalopoda in the Fauna of the Lias. Discussed by Messrs. Newberry and Cope.
16. WARD, L. F.; presented by J. W. Powell: The Evidence of the Fossil Plants as to the Age of the Potomac Formation.
17. LANGLEY, S. P.: Vision and Energy.
18. ROWLAND, H. A.: Report of Progress in Spectrum Photography.
19. ROWLAND,: H. A.: Note on the Spectrum of Carbon and its Existence in the Sun.
20. REMSEN, IRA: On the Constitution of the so-called Double Halogen Salts. (Read by title.)
21. REMSEN, IRA: Studies on the Rate of Decomposition of the Bromides of the Saturated Alcohol Radicals. (Read by title.)
22. GILL, THEO.: The Characteristics of the Orders and Sub-orders of Fishes.
23. PUTNAM, F. W.: The Serpent Mound and its Surroundings.
24. RILEY, C. V.; presented by Theo. Gill: The Systematic Relations of Platypsyllus as determined by the Larva.
25. PETERS, C. H. F.: On the Position of the Nova of 1572, as determined by Tycho Brahe. Discussed by A. Hall.
26. NEWBERRY, J. S.: Some Notes on the Laramie Groups. (Read by title.)
27. NEWBERRY, J. S.: On the Structure and Relations of Placoderm Fishes. (Read by title.)

RECOMMENDATIONS FROM THE COUNCIL.

The following recommendations from the council were adopted by the Academy:

1. That Mr. Edward Hayes be appointed recording secretary for the *present meeting.*

2. That the assessment for the ensuing year be $5.

3. Formal resolutions for the assignment of the District of Columbia 3.65 registered bonds, and for collecting the interest on the Philadelphia city loans, as follows:

Resolved, That Dr. John S. Billings, treasurer of the Academy, be, and he is hereby, authorized and empowered to assign any and all District of Columbia 3.65 registered bonds now standing, or which may hereafter stand, in the name of the Academy, and to appoint one or more attorneys for this purpose.

Resolved, That Dr. J. S. Billings, treasurer, be, and he is hereby, authorized to collect the interest now due, and hereafter to become due, on all loans of the city of Philadelphia now standing, or which may hereafter stand, in the name of the Bache fund of the National Academy of Sciences, and belonging to the Academy.

ELECTIONS.

The following members were selected for the council for the ensuing year: Messrs. G. J. Brush, B. A. Gould, S. P. Langley, M. C. Meigs, E. C. Pickering, and Ira Remsen.

REPORTS OF COMMITTEES.

The committee on ways and means to provide a fund for the Academy, the committee on publications of the Academy, and the committee on the relations of the Academy to the Government, made brief reports.

Mr. Langley was appointed a member of the committee on the relations of the Academy to the Government, to fill the vacancy caused by Professor Baird's death.

For the committee on publication, the home secretary stated that the second part of Vol. III of the memoirs was issued last July, and that about four hundred copies were sent to scientific societies and correspondents abroad. The printing of the volume for 1886 had begun, the long delay being on account of the plates. He also stated that numerous scientific publications have been received since the last meeting.

The president appointed Dr. Billings a member of this committee, to fill the vacancy caused by Professor Baird's death.

Mr. Gibbs, for the board of direction of the Bache fund, presented, in a report, a complete list of all the appropriations which have been made up to the present time.

It was moved and adopted that this committee be requested to make for publication a detailed report of the expenditures of the fund from the beginning to the present time, and that they continue it hereafter annually.

The president stated that the Bache fund was not confined to the physical sciences, but extended also to the natural sciences.

Mr. Newcomb, the chairman of the board of trustees of the Watson fund, made a report, in which it was recommended that the Watson medal and $100 in gold be awarded to Prof. Edward Schönfeld, director of the University Observatory at Bonn, for his services in cata-

logging and mapping the stars visible in our latitudes, and especially for his recently published Southern "Durchmusterung." This report was adopted.

The president stated that the committee on the Henry Draper medal had made a report, recommending that the medal be given to Prof. E. C. Pickering, of Harvard Observatory, which recommendation had been adopted.

The president also stated that, in a report from the committee on the J. Lawrence Smith medal, which was received after the November meeting, it was unanimously recommended that the medal be given to Prof. H. A. Newton, of Yale University. On motion, this recommendation was adopted.

The members present of the committees on the Henry Draper and Lawrence Smith medals submitted a statement and recommendation relating to a proposed change in the terms of the deeds of gift of these funds, and the president was requested to confer with the donors on this subject.

PRESENTATION OF MEDALS.

At a public session of the Academy, held on the evening of April 18, the second Henry Draper medal was presented by the president, in behalf of the academy, to Prof. E. C. Pickering, for his work in astronomical photography, and the first J. Lawrence Smith medal, to Prof. H. A. Newton, for his investigations on meteors.

At the same session, the following biographical memoirs were read:

Of Prof. James C. Watson, by Prof. G. C. Comstock. (Read by Mr. Gould.)

Of Prof. Henry Draper, by Prof. G. F. Barker.

Of Capt. James B. Eads, by William Sellers. (Read by title.)

REPORT OF THE COMMITTEE ON THE HENRY DRAPER MEDAL.

To the National Academy of Sciences:

The committee on the Henry Draper medal begs leave herewith to report that it has carefully considered the investigations which have been made in astronomical physics since the award of this medal in 1885, and that, as a result of such consideration, the said committee desires to recommend that the Academy award this medal for the year 1887 to our fellow member, Prof. Edward C. Pickering, the director of the Harvard College Observatory, for his recent work in astronomical photometry and photography.

Professor Pickering was appointed to the position which he now holds in February, 1877. An examination of the annual reports, which he has presented to the visiting committee of the observatory, will show the great amount and the great variety of the work which has been done there under his direction. Some of this work is purely astronomical, as an example of which, the excellent meridian circle work of Prof.

William A. Rogers may be mentioned. But most of it is in the department of astronomical physics, and this it is to which the committee desires to direct attention.

The work in astronomical physics, which has been done in the observatory of Harvard College under Professor Pickering's immediate supervision, seems readily divisible into three classes:

(1) Stellar Photometry; (2) Stellar Photography; and (3) Stellar Spectrum Photography.

I. The principal subdivisions of the photometric work are as follows:

(1) Observations of Jupiter's satellites at their disappearances in the shadow of the planet, and their reappearances after the eclipse, with the object of determining the times at which these phenomena occur, with greater accuracy than had hitherto been practicable.

(2) The determination of the relative brightness of all stars visible to the naked eye in the latitude of Cambridge.

(3) The determination of the relative brightness of several thousand stars of the first nine magnitudes, in order to fix the value of the arbitrary scales usually employed in estimating stellar magnitudes.

(4) Comparisons of various objects at small apparent distances from each other, such as the components of double stars, different satellites of the same planet, etc.

(5) Numerous special investigations on proposed standards of magnitude, stars which have been used for comparision with variable stars, the light of nebulæ, etc.

All this photometric work has gone uninterruptedly forward with the aid of special photometers ingeniously devised for the purpose by Professor Pickering.

The observation of the eclipse of Jupiter's satellities has long been regarded as important, not only in determining the motions of the satellities themselves, but also in ascertaining the velocity of light. It is obvious that the observation of the disappearance or reappearance of a satellite is necessarily a photometric observation, and, therefore, that the subject is one to which improved means of photometric research are peculiarly applicable. But previous to Professor Pickering's undertaking, no one appears to have recognized the advantages resulting from the use of the photometric apparatus in the observation of these eclipses. Recently, however, these advantages have been recognized in France, and researches similar in character to those of Professor Pickering have been undertaken there.

It is not to be expected that the observations of the eclipses made at the Harvard College Observatory will be fully reduced and published until they have been continued through a complete revolution of Jupiter (about twelve years). The first observation of this sort was made on the 23d of June, 1878. Up to the beginning of the present year, the total number of eclipses observed was three hundred and fifty-eight, thirty-

nine of which had occurred since October, 1885. The accuracy with which an eclipse of the first satellite can be observed appears from the preliminary reductions to be very satisfactory, the probable error seeming to be less than a second of time. The eclipses of the three outer satellites will furnish results nearly as useful, since the greater number of comparisons obtained during each eclipse compensates to a considerable extent for the comparative slowness of the changes in the brightness of the object observed.

The meridian photometer of Professor Pickering was first brought into use in the summer of 1879. The work of determining by the aid of this instrument the relative brightness of the stars which are visible to the naked eye was begun on the 25th of October of that year, and was continued through seven hundred series of observations, four thousand two hundred and sixty stars being included in the catalogue. The total number of comparisons made was ninety-four thousand four hundred and seventy-six, four comparisons constituting a complete observation. These results, together with an extended discussion of the estimated magnitudes obtained for the same stars by careful observers, as well as the results of previous photometric determinations of their relative brightness, were published in Volume XIV of the Annals of the Observatory.

The success of this photometer led Professor Pickering to have a larger instrument constructed, of the same kind, but which could be applied to the measurement of telescopic stars. The new photometer has given perfect satisfaction, and has enabled the brightness of stars to the ninth magnitude to be measured with a deviation from accuracy not exceeding a tenth of a magnitude. Moreover, stars can be measured with this instrument at the rate of forty stars an hour for an entire evening; and, under favorable conditions, even one star a minute may be thus measured. During the year 1886 two hundred and nine series of measurements were made by Professor Pickering and his assistant, the total number of separate photometric comparisons being fifty-nine thousand eight hundred. In 1885 fifty thousand such comparisons were made, and in 1884 twenty-seven thousand five hundred. A comparison of the Cambridge results with those obtained at Pulkowa shows that the average deviation of a measurement of the difference in brightness between two stars observed at both places does not exceed one tenth of a magnitude. The principal work of the meridian photometer, the revision of the Durchmusterung magnitudes, is now approaching completion, nine tenths of the observations having already been made.

It would seem to be manifest from the facts above enumerated that practical stellar photometry has now been carried on for the first time by Professor Pickering to that extent and with that completeness which are requisite to give it general interest and importance.

II. The earliest investigations in stellar photography, which were

undertaken by Professor Pickering, were begun in 1882, with the aid of a grant from the Rumford fund of the American Academy. They have been continued subsequently by an appropriation made in June, 1885, from the Bache fund of the National Academy. The work which has been done in this direction has been summarized as follows:

The present research was undertaken in 1882, with a lens having an aperture of only 2¼ inches. It was shown that photography could be used as a means of forming charts of large portions of the sky, and of determining the light and color of stars in all portions of the heavens. Photographs of the trails of close polar stars no brighter than the eleventh magnitude were obtained without clock-work. In 1885 the investigation was resumed with a telescope having an aperture of 8 inches. With this, one hundred and seventeen stars within one degree of the pole, one of them no brighter than the fourteenth magnitude, left trails. The average deviation of the measures of the brightness of these stars on different photographs was less than a tenth of a magnitude; a greater accordance than is given by any other photographic method. A similar result was obtained from the Pleiades, of which group over fifty left trails. Similar trails are now being obtained of the stars north of -30° in all right ascensions. This work began in the autumn of 1885, at 23^{h}, and has already been completed for more than half of the sky. By photographing on the same plate polar stars near their upper and lower culminations, material has been accumulated for determining the atmospheric absorption each night of observation.

A study has been made of the application of photography to the transit instrument. Measurements of the trails show that the time of a star's transit may be determined from its trail, with an average deviation of 0.03 second, which is about half the corresponding deviation of eye observations.

Charts may be constructed 5° square, having the same dimensions as those of Peters and Chacornac. A single exposure of one hour is required, and it is not necessary that the observer should remain with his eye at the telescope to correct the errors of the clock. Miscellaneous observations have been secured of the Pleiades, of the nebula in Orion, of Jupiter's satellites, and of various other objects.

III. Stellar spectrum photography, in which Professor Pickering has achieved his most marvelous results, was undertaken by him first in 1885, upon a plan entirely novel. Two important features of advantage were possessed by the new arrangement. The first consisted in placing the prism in front of the object-glass; a plan already suggested by Fraunhofer, and tried for eye observations by Secchi. The second consisted in placing the refracting edge of the prism parallel to the motion of the star; *i. e.*, if the star were on the meridian, the refracting edge would be horizontal, and the spectrum north and south. The first device gives not only an enormous increase of light, but renders it possible for the stars over the entire field to impress their spectra upon the plate. Hence, while previous observers have been able to photograph but one star at a time, and have not obtained satisfactory results from stars fainter than the second or third magnitude, Professor Pickering has often obtained more than a hundred spectra on a single plate, many of them of stars not brighter than the seventh or eighth magnitude. By means of the second device, the necessary width of the spectrum is secured. If clock-work were employed, the spectrum of a star would be a line too narrow to show any details. Formerly, a cylindrical lens

was used to widen the spectrum; but by placing the prism as above, and by suitably varying the rate of the clock, any desired width can be given to the spectrum, simply by the motion of the star itself. One millimeter was found to be the best width.

The first experiments were made in May, 1885, by placing a 30° prism in front of a lens of 2½ inches aperture. No clock-work was used, the spectra being formed of the trails of the stars. In the spectrum of the pole star over a dozen lines could be counted, and in that of α Lyræ the characteristic lines were shown very clearly with an exposure of only two or three minutes. In the fall of 1885, two prisms were obtained 20 centimeters in clear aperture, and having angles of 5° and 15° respectively. These could be placed in front of the object-glass of the 8-inch photographic telescope. With this apparatus, systematic operations were begun. The research, however, proved too large for the Bache appropriation. Whereupon, Mrs. Henry Draper came forward early in 1886, and generously offered not only to defray the expenses of the investigation as a memorial to Dr. Draper, but to put at Professor Pickering's disposal the 11-inch contractor, with its photographic corrector, with which Dr. Draper had taken many of his later stellar spectrum photographs. The investigation was thereupon extended by Professor Pickering and divided into three parts. The first included a general survey of stellar spectra, each spectrum being photographed with an exposure of not less than five minutes. These photographs generally exhibited the spectra of all stars brighter than the sixth magnitude with sufficient distinctness for measurement. The second research related to a determination of the spectra of the fainter stars. Each photograph taken received an exposure of one hour, so that the spectra of all the stars not fainter than the eighth or ninth magnitude, and included in a region ten degrees square, were represented upon the plate. For both these investigations, the 8 inch Bache photographic telescope was employed. The third research related to a more detailed study of the spectra of the brightest stars. For this work, the Henry Draper 11-inch corrected refractor was used, Mrs. Draper having provided a small observatory for it in Cambridge, and also the mounting. Four prisms were constructed, each of 15°, of which, three had a clear aperture of nearly 11 inches, the fourth being somewhat smaller, the whole weighing more than a hundred pounds, and occupying a cubic foot of space.

The results already attained in these three directions have been satisfactory. In the first research, the first cycle covering the entire sky from zero to twenty-four hours of right ascension has been completed. This cycle contains two hundred and fifty-seven plates, all of which have been measured and a large part of the reduction completed. Eight thousand three hundred and thirteen spectra have been measured on them, nearly all of which have been identified, and the places of a *greater* portion of the stars brought forward to the year 1900 and en-

tered in catalogue form. In the second cycle, which will complete the work, sixty-four plates have been taken, of which fifty-one, including two thousand nine hundred and seventy-four spectra have been measured and identified. In the second research, which has been carried on in the intervals when the telescope was not needed for other purposes, ninety-nine plates, with the exposure of an hour, have been obtained, on which four thousand four hundred and forty-two spectra have been measured; in one case, over three hundred spectra being shown on a single plate. In both these researches, taken together, fifteen thousand seven hundred and twenty-nine spectra of bright and faint stars have been measured. In the third research, the first results of which were obtained in October last, a considerable number of excellent photographs have been obtained, the results of which can be stated only after a long series of measurements and a careful reduction and discussion of them. Some points of interest, however, are shown on inspection. A photograph of α Cygni, taken November 26, 1886, shows that the H line is double, its two components having a difference in wave-length of about one ten-millionth of a millimeter.* A photograph of Omicron Ceti shows that the lines G and H are bright, as are also four of the ultra-violet lines, characteristic of spectra of the first type. The H and K lines in this spectrum are dark, showing that they probably do not belong to that series of lines. The star near X′ Orionis, discovered by Gore in December, 1885, gives a similar spectrum, which affords additional evidence that it is a variable of the same class as O. Ceti. Spectra of Sirius show a large number of faint lines beside the well-known broad lines.

Professor Pickering has also devised a new method of enlarging these original photographs, which also removes the inequalities in density in the negatives, appearing as bands parallel to the length of the spectrum. A cylindrical lens is placed close to the enlarging lens, with its axis perpendicular to the spectrum lines. In this way the length of the spectrum is increased only five times, while its width is increased nearly one hundred, *i. e.*, from one millimeter to about four inches. This arrangement greatly reduces the difficulty arising from the feeble light of the star.

Until very lately, the spectra in the original negatives were made very narrow, since otherwise, the intensity of the starlight would have been insufficient to produce the proper decomposition of the silver particles. The enlargement being made by daylight, the vast amount of energy then available is controlled by the original negative, the action of which may be compared to that of a telegraphic relay. The copies, therefore, represent many hundred times the original energy received from the stars.

The deed of trust under which this committee is acting provides "that

* It has long been known that the H line is also double (bright) in the spectrum of the solar chromosphere.

the investigation for which it (the Henry Draper medal) is awarded, or the completed publication thereof, shall have been made since the time of the last preceding award and presentation of said medal." In consequence, the committee recommends the award to Professor Pickering, for the specific investigations in stellar photometry and photography above mentioned, which have been made since the month of April, 1885, the time of the last preceding award and presentation of said medal. This comprises, it is believed, the whole of the photographic work done at the Harvard College Observatory, and a large and important part of the photometric work.

In the opinion of the committee, Professor Pickering has displayed in these researches a skill, ingenuity, and vigor which entitle him to an honorable place among the scientific men of our own or any previous age.

All of which is respectfully submitted.

GEORGE F. BARKER,
WOLCOTT GIBBS,
SIMON NEWCOMB,
CHARLES A. YOUNG,
ARTHUR W. WRIGHT,
Committee on the Henry Draper Medal.

WASHINGTON, D. C., *April* 21, 1887.

REPORT OF THE COMMITTEE ON THE J. LAWRENCE SMITH MEDAL.

To the National Academy of Sciences:

In recognition of his eminent services in the investigation of the origin of meteors, the Academy, upon the unanimous recommendation of the committee on the Lawrence Smith medal, has awarded the first gold medal of this foundation to Prof. Hubert Newton, of New Haven. The report of the committee is as follows:

Professor Newton's study of the subject has extended over a long series of years, and has led to results of very great popular interest as well as scientific importance. Meteors, in the sense in which the word is now used, have from the remotest ages attracted the attention of mankind. Observations of greater or less value have long been accumulating. Chemists had shown that meteoric bodies which fell upon the earth contained no element not already known as a constituent of the crust of the earth, but astronomy had not yet brought the wanderers of the heavens into a system, and shown that they are moving in definite orbits, and are not distributed by chance in the celestial spaces. Professor Newton's first paper was published in 1860, and was succeeded by a number of others.

From a careful analysis of the early observations of the Arabo, going back to the year 902, as well as of modern observations, Professor Newton showed that the connection between the November star-showers of

1799 and 1833 had been concealed by the fact that the day of the shower was moving from October 12, A. D. 902, to November 13, 1833. The shower was thus traced back over nine hundred years, and the persistence of the thirty-three year period was distinctly shown. It was also proved that the paths in which the meteors are moving about the sun must be one of five sharply-defined orbits. A method of deciding which of these was the true one was suggested. Professor Adams, of Cambridge (England), then showed in the manner indicated which orbit was the correct one, and so prepared the way for proving beyond question, as soon as Oppolzer published the orbit of the comet of 1886, that this comet and the November meteors belonged to one system. Schiaparelli had first shown that the August meteors belonged to the same system as another comet.

In a memoir on shooting-stars, published in the memoirs of the National Academy (read August 6, 1864), Professor Newton for the first time proved that the orbits of these bodies are not approximately circular like those of the planets, but that they resemble more the parabolic orbits of comets. This was the first step toward the establishment of a relationship between comets and meteors. In the same memoir, Professor Newton undertook to show how many shooting-stars enter the air each day. The result of the discussion was the number 7,500,000, but later observations increase this number materially, and perhaps even double it. Another interesting and suggestive question also considered was this—as the earth moves round the sun, how thickly filled with meteorites is the space which it traverses? To this question the answer given is, as a first approximation, 13,000 in each unit of space of the size of the earth itself.

In a subsequent paper, Professor Newton made an attempt to determine whether comets come originally from the solar system or from outside of it. The investigation was based upon observed facts, and the results obtained are still under consideration by astronomers. The argument that the meteoric stones of our cabinets were all fragments of comets was again brought out in a lecture delivered at the Sheffield Scientific School. This again was followed by a paper on the effect upon the earth's velocity produced by small bodies passing near the earth. In this paper it is shown that while small bodies which pass near the earth but do not meet it have a real effect in stopping the earth or the moon, this effect is much too small to be sensible.

In a discussion of the Biela meteors of November 27, 1885, Professor Newton, among other facts, brought out the very interesting and important one that the meteors left the comet since 1840, and that the disintegration of the comets furnishing meteor streams is a more rapid process than has been usually supposed.*

* In a paper read before the National Academy of Sciences, April 19, 1888, Professor Newton has further established the following propositions:

(1) The meteorites which we have in our cabinets, and which were seen to fall,

In the judgment of the committee these researches are of a very high order of merit and of interest.

WOLCOTT GIBBS,
GEORGE J. BRUSH,
RAPHAEL PUMPELLY,
ASAPH HALL,
LEWIS M. RUTHERFURD,
Committee on the J. Lawrence Smith Medal.

TREASURER'S REPORT.

The treasurer presented the following report, which had been examined by the auditing committee, Messrs. Meigs, Hague, and Abbe, and approved:

1. *General account, April 20, 1887, to April 17, 1888.*

RECEIPTS.

Balance April 20, 1887	$167.46
Fees for 1887	480.00
Interest on $500 District of Columbia bonds, 3.65 per cent	18.26
Expenses, opium committee, refunded	83.27
Total receipts	748.99

DISBURSEMENTS.

Recording secretary	$25.00	
Lunches, April meeting	100.00	
Filling diplomas	5.25	
Printing constitution	30.50	
Rent of safe in vault	15.00	
Expenses of committee, opium examination	83.27	
Secretary's account, stationery, etc	17.06	
Expenses of meeting in New York	175.10	
Printing notices	3.75	
Postage account	5.00	
Printing memoirs	65.50	
Printing circulars	8.00	
Printing blanks for tax and envelopes	2.00	
Total expenditures		535.43
Balance on hand April 17, 1888		213.56
Available balance		798.56

were originally (as a class, and with a very small number of exceptions) moving around the sun in orbits that had inclinations less than 90°; that is, their motions were direct and not retrograde.

(2) The reason why we have only this class of stones in our collections is not one wholly or even mainly dependent on the habits of men, nor on the times when men are out of doors, nor on the places where men live, nor on any other principle of selection acting at or after the arrival of the stones at the ground. Either the stones which are moving in the solar system across the earth's orbit move in general in direct orbits, or else, for some reason, the stones which move in retrograde orbits do not in general come through the air to the ground in solid form.

(3) The perihelion distances of nearly all the orbits in which these stones moved *were not less than 0.5,* nor more than 1.0, the earth's radius-vector being unity.

2. *The Bache trust fund.*

RECEIPTS.

Balance on hand April 20, 1887	$2,350.73
Interest on $42,100 United States bonds at 4½ per cent	1,894.48
Interest on $3,850 United States bonds at 4 per cent	154.00
Interest on $1,500 District of Columbia bonds at 3.65 per cent	54.74
Total receipts	4,453.95

DISBURSEMENTS.

Professor Newcomb, photographing eclipse of sun in Japan	$2,000.60	
Professor Michelson, determining the velocity of light	500.00	
Professor Gibbs, action of chemical compounds on animal system	301.50	
Tax on Missouri lands	3.63	
Total expenditures		2,805.13
Balance, April 17, 1888		1,648.82
District of Columbia bonds, $1,500 at 117		1,755.00
Total assets		3,403.82
Outstanding order for Prof. S. P. Langley	2,500.00	
Outstanding order for Prof. Wolcott Gibbs	698.50	
Total		3,198.50
Available balance		205.32

3. *The Watson trust fund.*

RECEIPTS.

Balance, April 20, 1887	$1,415.05
Interest on $6,200 4½ per cent. bonds	279.00
Interest on $850 4 per cent. bonds	34.00
Dividend from Michigan Mutual Insurance Company	469.00
Total receipts	2,197.05

4. *The Henry Draper medal fund.*

RECEIPTS.

Balance April 20, 1887	$568.54
Interest on $5,000 4 per cent. United States bonds	200.00
Total receipts	768.54

DISBURSEMENTS.

T. C. Chaplain, Pickering medal	202.90
Balance April 17, 1888	565.64

5. *The J. Lawrence Smith medal fund.*

RECEIPTS.

Balance April 20, 1887	818.00
Interest on $7,200 4½ per cent. bonds	324.00
Total receipts	1,142.00

DISBURSEMENTS.

T C. Chaplain, Newton medal	$202.90
Balance April 17, 1883	939.10

JOHN S. BILLINGS, *Treasurer National Academy of Sciences.*

The following report of the committee appointed to examine the securities held by the Academy was read and approved.

WASHINGTON, D. C., *April* 18, 1888.

The committee, Messrs. Remsen and Wright, appointed to examine the securities in the hands of the treasurer, report that they have examined the said securities and find that they are as follows:

1. *General fund.*

District of Columbia 3.65 bonds	$500.00

2. *Bache trust fund.*

United States 4½ per cent. bonds, registered	$42,100	
United States 4 per cent. bonds, registered	3,850	
Davenport 6 per cent. bonds, coupon	1,000	
Philadelphia 6 per cent. bonds, registered	600	
		47,550

Deed for 160 acres of Missouri lands to A. D. Bache, not transferred to the Academy.

3. *Invested income of the Bache fund.*

District of Columbia 3.65 bonds	$1,500

4. *Joseph Henry fund.*

An agreement with the Pennsylvania Company for insurance on lives and granting annuities, as to the final disposition of the Joseph Henry fund of $40,000. The above will not be available until the decease of all of Professor Henry's children.

5. *Watson trust fund.*

United States 4½ per cent. bonds, registered	$6,200	
United States 4 per cent. bonds, registered	850	
Certificate for 134 shares of the capital stock of the Michigan Life Insurance Company	6,700	
		13,750

6. *Henry Draper Medal fund.*

United States 4 per cent. bonds, registered	5,000

Deed of trust of Mary Anna Palmer Draper to the National Academy of Sciences.

7. *J. Lawrence Smith Medal fund.*

United States 4½ per cent. bonds, registered	7,200

Deed of trust of Sarah Julia Smith to the National Academy of Sciences.

Amount of available securities	75,500

CONSTITUTIONAL AMENDMENT.

The pending amendment to Article VI, section 1, of the constitution, was adopted, as follows:

All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States; or, with the approval of the council, in State bonds, or first-mortgage bonds, or real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

NEW RULE.

The following new rule was adopted:

At least sixty days before the election the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of the list of the more important works of the nominee, to enable the secretary to furnish a copy to each member of the Academy.

The recommendation of the president to renumber and rearrange the rules so as to bring matters on the same subject together was referred to the council, with power to act.

NEW MEMBERS.

The following new members were elected: Messrs. G. Brown Goode, Albert A. Michelson, and Seth C. Chandler.

NOMINATIONS.

Thirteen nominations for membership in the Academy were read.

DEATH OF MEMBERS.

The president announced the death, since the last meeting, of Prof. Asa Gray, and of Dr. Ferdinand V. Hayden.

The following members were appointed to prepare biographical memoirs:

Of Prof. Asa Gray, Professor Farlow.

Of Dr. F. V. Hayden, Prof. Joseph Leidy.

The president brought before the Academy an invitation from the University of Bologna, requesting that a delegate be sent to represent the Academy at the eight hundredth anniversary of that institution. This celebration was to be held in June, 1888.

It was moved and adopted that the matter be referred to the president, with power to act.

The president subsequently appointed Dr. S. Weir Mitchell as delegate to represent the Academy on this occasion.

It was moved and adopted that the home secretary be requested to present the thanks of the Academy to the Cosmos Club for courtesies extended during the present session.

The Academy adjourned April 20, 1888, to meet in New Haven, Conn., November 13, 1888.

SCIENTIFIC SESSION.

HELD IN NEW HAVEN, CONN., NOVEMBER 13 TO 15, 1888.

A scientific session, for the reading of papers only, having been called by the council, as announced at the April session, the Academy met in the north hall of the Sheffield Scientific School, New Haven, Conn., on November 13, 1888. The meetings were continued on the 14th and 15th.

The president, Prof. O. C. Marsh, presided.

The following members were present during the session:

Billings,	Gibbs, J. W.	Marsh,	Powell,
Brewer,	Gibbs, W.	Michelson,	Pumpelly,
Brush,	Gilbert,	Mitchell, H.	Scudder,
Chandler, C. F.	Gould,	Morse,	Smith,
Chandler, S. C.	Hague,	Newberry,	Trowbridge, J.
Cook, G. H.	Hall, A.	Newton, H. A.	Verrill,
Cope,	Hall, J.	Newton, J.	Walker,
Dana, E. S.	Johnson,	Packard,	Wright.
Dana, J. D.	Langley,	Peters,	

The following papers were read and discussed:

1. HOLDEN, E. S.: The Lunar Eclipse, July 22, 1888.
2. BOSS, LEWIS; presented by A. Hall: The Zone Undertaking of the Astronomische Gesellschaft.
3. LOOMIS, ELIAS: The Rain-Fall of the North Atlantic Ocean.
4. BREWER, W. H.: A Finished Breed of Horses.
5. GIBBS, WOLCOTT, and HARE, HOBART EMORY: A Systematic Study of the Action of Definitely Related Chemical Compounds upon Animals.
6. NEWBERRY, J. S.: The Cretaceous Flora of North America.
7. NEWBERRY, J. S.: On the Zoological Relations of some Palæozic Fishes.
8. OSBORN, HENRY F., presented by E. D. Cope: The Evolution of the Mammalian Molar Teeth to and from the Tritubercular Type.
9. LEE, L. A., presented by A. E. Verrill: Some Scientific Results of the Albatross Expedition from Washington to San Francisco.
10. MICHELSON, A. A., and MORLEY, E. W.: Some Measurements of Relative Wave-lengths.
11. DANA, E. S.: A new Mineral from Maine.
12. PETERS, C. H. F.: Remarks on the Expression of the Law of Attraction in the Stellar Systems.
12. HALL, A.: Note on the Satellite of Neptune.
14. GILBERT, G. K.: The Problem of Soaring Birds (read by title).
15. POWELL, J. W.: The Laws of Corrosion.

The scientific session closed November 15, to meet in Washington, April 16, 1889

SPECIAL SESSION.

HELD IN NEW HAVEN, CONN., NOVEMBER 14, 1888.

A special session of the Academy having been called by the council, in accordance with Article III, section 1, of the constitution, the Academy convened at North Sheffield Hall, November 14, 1888; the president, Prof. O. C. Marsh, presiding.

The president stated that the object of the meeting was to consider his annual report to Congress.

RECOMMENDATION FROM THE COUNCIL.

The home secretary read the following recommendation from the council, which was adopted:

That the president be authorized to present his annual report to Congress, and to include in this report the proceedings of the present meeting.

The home secretary also read the following statement from Mr. Newcomb, chairman of the board of trustees of the Watson fund:

WASHINGTON, D. C., *October* 19, 1888.

To the President of the National Academy of Sciences:

The trustees of the Watson fund have voted to expend a sum not exceeding $800, to enable Prof. G. C. Comstock to make a determination of the constant of aberration at the Madison Observatory. I am requested to ask an approval of this action by the Academy.

Very respectfully,

SIMON NEWCOMB.

It was moved that this action of the trustees of the Watson fund be approved. This motion was adopted by the Academy.

The president and home secretary explained the condition of the printing of the memoirs of the Academy. Part I, of Volume IV, had been completed, and would soon be ready for distribution.

NOMINATIONS.

Two nominations for membership in the Academy were read.

DEATH OF MEMBER.

The president announced the death of Prof. A. H. Worthen, a member of the Academy, who died May 6, 1888, at Springfield, Ill.

Mr. Leo Lesquereux was appointed to prepare the biographical memoir.

The special session was then adjourned.

Respectfully submitted.

O. C. MARSH,

President of the National Academy of Sciences.

APPENDICES.

APPENDIX A.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. LeConte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Peirce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Masachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, Califoruia; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation *hereby constituted* shall have power to make its own *organization, including its* constitution, by-laws, and rules and regula-

tions; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March three, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June* 10, 1882.

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June* 24, 1884.

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

APPENDIX B.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875, April 21, 1881, April 19, 1882, April 18, 1883, and April 19, 1888.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States, on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council, shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its session next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those *for the transaction* of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special meetings may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election for officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected, and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he received two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session

of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president, and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author, or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be, at all times, at the dis-

position of the Government, upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation, submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States; or, with the approval of the council, in State bonds, or first mortgage bonds, or real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receives two-thirds of the votes cast, it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the member were present.

RULES.

I. In the absence of any officer, a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected by a plurality

of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented, which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year, and referred with the accounts to the auditing committee.

IV. A committee of arrangements consisting of five members shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members; to arrange the business of each day; to receive the titles of papers, reports, etc.; and to arrange the order of reading, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to fix the length of time to be devoted to reading of all papers submitted, and to limit the time to be occupied in their discussion.

V. At the meetings, the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.
8. On the last days of the session, the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings shall be convened at noon.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session. But no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date in the records of the Academy from the date of their presentation to the Academy, and the order of their presentation shall be that in which they were registered, unless changed by consent of the author.

XI. Papers from persons not members, read before the Academy, and intended for publication, shall be referred, at the meeting at which they are read, to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. An annual of the Academy shall be prepared and published by the secretaries.

XIII. The printing of the Academy shall be under the charge of a committee of publication, to consist of the home secretary, and four other members to be named by the president, with the advice and consent of the council.

XIV. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XVI. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVII. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels, or other proper marks of similar device, shall be placed upon objects not admitting of the stamp.

XVIII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of departments of the Government, and in each case to look to the department requesting the investigation for re-imbursement to the Academy.

XIX. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XX. At least sixty days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of the list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XXI. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXII. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXIII. Any rule of the Academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, *ex officio*, a member of all Government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1888.

	Expiration of term.
MARSH, O. C., *President*	April, 1889.
NEWCOMB, S., *Vice-President*	April, 1889.
GIBBS, WOLCOTT, *Foreign Secretary*	April, 1892.
HALL, A., *Home Secretary*	April, 1889.
BILLINGS, JOHN S., *Treasurer*	April, 1893.

ADDITIONAL MEMBERS OF COUNCIL, 1888–'89.

BRUSH, G. J.
GOULD, B. A.
LANGLEY, S. P.
MEIGS, M. C.
PICKERING, E. C.
REMSEN, IRA.

COMMITTEES OF THE ACADEMY.

On Ways and Means to Provide a Fund for the Academy.

ROGERS, FAIRMAN, *Chairman.*
CHANDLER, C. F.
MARSH, O. C.
MITCHELL, S. WEIR.
PUMPELLY, R.

On Weights, Measures, and Coinage.

BARNARD, F. A. P., *Chairman.*
GIBBS, WOLCOTT.
HILGARD, J. E.
MEIGS, M. C.
NEWCOMB, S.
NEWTON, H. A.
PEIRCE, C. S.
TROWBRIDGE, W. P.

On the Election of Foreign Associates.

GIBBS, WOLCOTT, *Chairman.*
DANA, J. D.
GOULD, B. A.
HALL, A.
NEWCOMB, S.

On Reserving Public Lands on and near Mount Whitney, California, for Scientific Purposes.

LANGLEY, S. P., *Chairman.*
BREWER, W. H.
POWELL, J. W.

On Publication.

THE HOME SECRETARY.
BILLINGS, J. S.
COFFIN, J. H. C.
NEWCOMB, S.
POWELL, J. W.

On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.
LANGLEY, S. P.
COFFIN, J. H. C.
HILGARD, J. E.
MEIGS, M. C.
POWELL, J. W.

GOVERNMENT COMMITTEES.

On Opium, 1887.

REMSEN, IRA, *Chairman.*
BARKER, G. F.
CHANDLER, C. F.

On Classification of Sugar.

WRIGHT, A. W., *Chairman.*
DANA, E. S.
HASTINGS, C. S.

TRUST FUNDS.

Board of Direction of the Bache Fund.

DANA, J. D., *Chairman.*
HILGARD, J. E.
GIBBS, W.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.*
COFFIN, J. H. C.
GOULD, B. A.

On the Henry Draper Medal.

BARKER, G. F., *Chairman.*
GIBBS, W
NEWCOMB, S.
WRIGHT, A. W.
YOUNG, C. A.

On the J. Lawrence Smith Medal.

GIBBS, WOLCOTT, *Chairman.*
BRUSH, G. J.
HALL, A.
PUMPELLY, R.
RUTHERFURD, L. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY, 1889.

		Date of election.
ABBE, CLEVELAND	*Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A.	*Army Building, New York.*	1872
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	3909 *Locust St., Philadelphia, Pa.*	1879
BARNARD, FREDERICK A. P.	*New York City.*	——
BARTLETT, WILLIAM H. C	75 *Locust Hill Ave., Yonkers, N. Y.*	——
BELL, A. GRAHAM	*Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*Washington, D. C.*	1883
BOWDITCH, HENRY P	*Cambridge, Mass.*	1887
BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BROWN-SEQUARD, CHARLES E	*Paris, France.*	1868
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	16 *Craigie St., Cambridge, Mass.*	1888
COFFIN, JOHN H. C., U. S. N	*Washington, D. C.*	——
COMSTOCK, CYRUS B., U. S. A	*Army Building, New York City.*	1884
COOK, GEORGE H	*New Brunswick, N. J.*	1887
COOKE, JOSIAH P	*Cambridge, Mass.*	1872
COPE, EDWARD D	2100 *Pine St., Philadelphia, Pa.*	1872
COUES, ELLIOTT	*Washington, D. C.*	1877
CRAFTS, JAMES M	59 *Marlborough St., Boston.*	1872
DALTON, J. C	43 *W. Forty-eighth St., New York City.*	1864
DANA, EDWARD S	*New Haven, Conn.*	1884
DANA, JAMES D	*New Haven, Conn.*	——
DAVIDSON, GEORGE	*San Francisco, Cal.*	1884
DUTTON, CLARENCE E., U. S. A	*Washington, D.C.*	1884
FARLOW, W. G	*Cambridge, Mass.*	1879
FERREL, WILLIAM	1641 *Broadway, Kansas City, Mo.*	1868
GENTH, FREDERICK A	*West Philadelphia, Pa.*	1872
GIBBS, JOSIAH WILLARD	*New Haven Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOODE, G. BROWN	*Washington, D. C.*	1888
GOULD, BENJAMIN A	*Cambridge, Mass.*	——
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH, U. S. N	*Washington, D. C.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HILGARD, EUGENE W	*Oakland, Cal.*	1872
HILGARD, JULIUS E	*Washington, D. C.*	——
HILL, GEORGE W	*Washington, D. C.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*Berkeley, Cal.*	1885
HUNT, T. STERRY	*Montreal Canada.*	1873
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*New Haven, Conn.*	1866

		Date of election.
KING, CLARENCE	62 *Cedar St., New York.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LEIDY, JOSEPH	*Philadelphia, Pa.*	1884
LESLEY, J. PETER	1008 *Clinton St., Philadelphia, Pa.*	——
LE CONTE, JOHN	*Berkeley, Cal.*	1878
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LESQUEREUX, LEO	302 *Fourth St., Columbus, Ohio.*	1864
LOOMIS, ELIAS	*New Haven, Conn.*	1873
LOVERING, JOSEPH	*Cambridge, Mass*	1873
MARSH, O. C	*New Haven, Conn.*	1874
MAYER, ALFRED M	*Hoboken, N. J.*	1872
MEIGS, MONTGOMERY C., U. S. A	*Washington, D. C.*	1865
MENDENHALL, THOMAS C	*Terre Haute, Ind.*	1887
MICHELSON, ALBERT A	*Cleveland, Ohio.*	1888
MITCHELL, HENRY	*U. S. Coast Survey, Boston, Mass.*	1885
MITCHELL, S. WEIR	1524 *Walnut St., Philadelphia, Pa.*	1865
MORSE, EDWARD S	*Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWBERRY, J. S	*New York City.*	——
NEWCOMB, SIMON, U. S. N	*Washington, D. C.*	1869
NEWTON, H. A	*New Haven, Conn.*	——
NEWTON, JOHN, U. S. A	*New York City.*	1876
OLIVER, JAMES E	*Ithaca, N. Y.*	1872
PACKARD, A. S	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*U. S. Coast Survey, Washington, D. C.*	1877
PETERS, C. H. F	*Clinton, N. Y.*	1876
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs Arc., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	147 *S. Fourth St., Philadelphia, Pa.*	——
ROGERS, WILLIAM A	*Waterville, Me.*	1885
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
RUTHERFURD, LEWIS M	175 *Second Avenue, New York City.*	——
SCHOTT, CHARLES A	*Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	1600 *Hamilton St., Philadelphia, Pa.*	1873
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
TROWBRIDGE, WILLIAM P	*New York City.*	1872
TRUMBULL, J. H	*Hartford, Conn.*	1872
VERRILL, A. E	*New Haven, Conn.*	1872
WALKER, FRANCIS A	*Boston, Mass.*	1878
WOOD, HORATIO C	1925 *Chestnut St., Philadelphia, Pa.*	1879
WORTHEN, A. H	*Springfield, Ill.*	1872
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

HONORARY MEMBERS.

AGASSIZ, ALEXANDER	*Cambridge, Mass.*
LONGSTRETH, MEIRS F	*Derby, Pa.*
LYMAN, THEODORE	*Brookline, Mass.*

DECEASED MEMBERS.

	Date of death.
*AGASSIZ, LOUIS	Dec. 14, 1873
*ALEXANDER, J. H	Mar. 2, 1867
*ALEXANDER, STEPHEN	June 25, 1883
*BACHE, ALEXANDER DALLAS	Feb. 14, 1867
BAIRD, S. F	Aug. 19, 1887
BARNARD, J. G	May 14, 1882
*CASWELL, ALEXIS	Jan. 8, 1887
*CHAUVENET, WILLIAM	Dec. 13, 1870
*CLARK, HENRY JAMES	July 1, 1873
*COFFIN, JAMES H	Jan. 6, 1873
DAVIS, CHARLES H	Feb. 18, 1877
DRAPER, HENRY	Nov. 20, 1882
*DRAPER, JOHN W	Jan. 4, 1882
EADS, JAMES B	Mar. 8, 1887
ENGELMANN, GEORGE	Feb. 11, 1884
*FRAZIER, JOHN FRIES	Oct. 14, 1872
*GABB, WILLIAM M	May 30, 1878
*GILLISS, JAMES MELVILLE	Feb. 9, 1865
*GOULD, AUGUSTUS A	Sept. 15, 1866
GRAY, ASA	Jan. 30, 1888
*GUYOT, ARNOLD	Feb. 8, 1884
*HADLEY, JAMES	Aug. 1, 1864
*HALDEMAN, S. S	Sept. 20, 1880
HAYDEN, F. V	Dec. 22, 1887
*HENRY, JOSEPH	May 13, 1878
*HITCHCOCK, EDWARD	Feb. 27, 1864
*HOLBROOK, J. E	Sept. 8, 1871
*HUBBARD, J. S	Aug. 16, 1863
*HUMPHREYS, A. A	Nov. 28, 1883
*KIRTLAND, JARED P	Dec. 10, 1877
*LANE, J. HOMER	—— — 1880
*LE CONTE, JOHN L	Nov. 15, 1883
*MAHAN, D. H	Sept. 16, 1871
MARSH, G. P	July 23, 1892
*MEEK, F. B	Dec. 21, 1877
*MORGAN, LEWIS H	Dec. 14, 1881
*NORTON, WILLIAM A	Sept. 21, 1883
*POURTALES, L. F	July 17, 1880
RODGERS, JOHN	May 5, 1882
ROGERS, ROBERT E	Sept. 7, 1884
*ROGERS, WILLIAM B	May 30, 1882
*SAXTON, JOSEPH	Oct. 26, 1873
*SILLIMAN, BENJ., Sr	Nov. 24, 1864
SILLIMAN, BENJ., Jr	Jan. 14, 1885
*SMITH, J. LAWRENCE	Oct. 12, 1883
*STIMPSON, WILLIAM	May 26, 1873
*STRONG, THEODORE	Feb. 1, 1869
*SULLIVANT, W. S	Apr. 30, 1873
*TORREY, JOHN	Mar. 10, 1873
*TOTTEN, J. G	Apr. 22, 1864
*TUCKERMAN, EDWARD	Mar. 15, 1886
*WARREN, G. K	Aug. 8, 1882
WATSON, JAMES C	Nov. 23, 1880

	Date of death.
*WINLOCK, JOSEPH	Jan. 11, 1875
*WOODWARD, J. J., U. S. A	Aug. 17, 1884
WORTHEN, A. H	May 6, 1888
*WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

BUNSEN, ROBERT W	*Heidelberg.*
AIRY, SIR GEORGE B	*Greenwich.*
OWEN, RICHARD	*London.*
BURMEISTER, C. H. C	*Buenos Ayres.*
STRUVE, OTTO VON	*Pulkova.*
ADAMS, J. C	*Cambridge.*
CAYLEY, ARTHUR	*Cambridge.*
HELMHOLTZ, BARON H. VON	*Berlin.*
PASTEUR, LOUIS	*Paris.*
STOKES, G. G	*Cambridge.*
SYLVESTER, J. J	*Oxford.*
HOOKER, SIR J. D	*Kew.*
THOMSON, SIR WILLIAM	*Glasgow.*
AUWERS, ARTHUR	*Berlin.*
BERTRAND, J. L. F	*Paris.*
HUXLEY, T. H	*London.*
VIRCHOW, RUDOLPH VON	*Berlin.*
BERTHELOT, M. P. E	*Paris.*
CHEVREUL, M. E	*Paris.*
DE CANDOLLE, ALPHONSE	*Geneva.*
KÖLLIKER, ALBERT VON	*Würzburg.*
RICHTHOFEN, F. VON	*Berlin.*
HOFMANN, A. W	*Berlin.*
JOULE, JAMES P	*Manchester.*

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.	SIR RODERICK I. MURCHISON.
KARL ERNST VON BAER.	VICTOR REGNAULT.
HENRY MILNE-EDWARDS.	H. W. DOVE.
MICHAEL FARADAY.	C. A. F. PETERS.
L. ELIE DE BEAUMONT.	JUSTUS VON LIEBIG.
SIR DAVID BREWSTER.	ALEXANDER BRAUN.
G. A. A. PLANA.	JOACHIM BARRANDE.
F. W. A. ARGELANDER.	ADOLPHE WÜRTZ.
FRIEDRICH WÖHLER.	THEODORE VON OPPOLZER.
J. B. DUMAS.	J. B. J. D. BOUSSINGAULT.
MICHEL CHASLES.	G. R. KIRCHOFF.
	RUDOLPH CLAUSIUS.

* Biographical notices have been presented of those designated by a *.

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1889.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1891.

LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., February 25, 1890.

SIR: In conformity with the requirements of the act of incorporation approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences during the past year.

Very respectfully,

O. C. MARSH,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

The National Academy of Sciences was established by act of Congress in March, 1863, with power to frame its own constitution, select its own members, and provide in other respects for its continuance and successful operation.

The object of the Academy is to advance science, and especially to investigate, examine, experiment, and report on any subject of science or art whenever called upon by any department of the Government.

The Academy contains at present about 100 members, and these have all been selected for their original researches in science. They represent within their ranks nearly every department of knowledge, and their services, in accordance with the charter of the Academy, are always at the disposal of the Government, without compensation.

SESSIONS OF THE NATIONAL ACADEMY.

During the past year, the Academy has held three sessions. The first was the regular annual meeting held in Washington, D. C., April 16 to 19, 1889; the second was a scientific session, in Philadelphia, November 12 to 14, 1889, and the third was a special session in Philadelphia, November 13, 1889.

STATED SESSION.

HELD IN WASHINGTON CITY, APRIL 16 TO 19, 1889.

The Washington session was held in the National Museum, the president, Prof. O. C. Marsh, presiding.

The following members were present during the session:

Abbe.	Cook, G. H.	Hilgard.	Newcomb.
Abbot.	Cope.	Hill, G. W.	Peirce.
Allen.	Dutton.	Hyatt.	Peters.
Barker.	Ferrel.	Langley.	Powell.
Bell.	Gibbs, W.	Marsh.	Pumpelly.
Billings.	Gilbert.	Mayer.	Putnam.
Brewer.	Gill.	Meigs.	Remsen.
Brooks.	Goode.	Mendenhall.	Rowland.
Brush.	Gould.	Michelson.	Schott.
Chandler, S. C.	Hague.	Mitchell, S. W.	Walker.
Coffin.	Hall, A.	Morton.	Wood.
Comstock.	*Hall, J.*	Newberry.	Wright.

At this session the following papers were read and discussed:

1. PEIRCE, C. S.: On Sensations of Color.
2. GIBBS, W., and HARE, H. H.: Notice on the Method and Results of a Systematic Study of the Action of Definitely Related Chemical Compounds upon Animals. (Read by Dr. Hare.)
3. COPE, E. D.: On the Pliocene Vertebrate Fauna of Western North America. Discussed by Messrs. Gilbert and Cope.
4. TODD, D. P.; presented by S. Newcomb: On Composite Coronagraphy. Discussed by Messrs. Langley and Peters.
5. PEIRCE, C. S.: On Determinations of Gravity.
6. COPE, E. D.: On the North American Proboscidia.
7. HALL, A., Jr.; presented by G. J. Brush: On the Mass of Saturn. Discussed by Messrs. A. Hall, G. W. Hill, Peters, and Newcomb.
8. REMSEN, IRA: On the Rate of Reduction of Nitro-compounds.
9. REMSEN, IRA: On Some Connection between Taste and Chemical Composition.
10. MENDENHALL, T. C.: Recent Researches in Atmospheric Electricity. Discussed by General Greely.
11. MICHELSON, A. A.: Measurement by Light Waves. Discussed by Mr. Rowland.
12. ROGERS, W. A.: Additional Experimental Proof that the Relative Coefficient of Expansion between Baily's Metal and Steel is Constant between the Limits Zero and Ninety-five Degrees Fahr. (Read by title.)
13. MICHELSON, A. A., and MORLEY, E. W.: On the Feasibility of the Establishment of a Light-wave as the Ultimate Standard of Length. Discussed by Messrs. Peirce, Rowland, and Michelson.
14. CHANDLER, S. C.: On the General Laws pertaining to Stellar Variations. Discussed by Messrs. Gould, G. W. Hill, Newcomb, Chandler, and Peters.
15. PETERS, C. H. F.: Review of the Trivial Names in Piazzi's Star Catalogue.
16. NEWBERRY, J. S.: On Cretaceous Flora of North America. Discussed by Messrs. Cope and Newberry.
17. HITCHCOCK, ROMYN; presented by A. Hall: Spectrum Photography in the Ultra-Violet. (Read by title.)
18. WALCOTT, C. D.; presented by R. Pumpelly: The Plane of Demarcation between the Cambrian and Pre-Cambrian Rocks. Discussed by Mr. Newberry.
19. TODD, D. P.; presented by S. Newcomb: Report of the American Eclipse Expedition to Japan, 1887.
20. REMSEN, IRA: On the Nature and Composition of Double Halides. (Read by title.)
21. ABBE, CLEVELAND: Terrestrial Magnetism. (Read by title.)
22. BROOKS, W. K.: North American Pelagidæ. (Read by title.)
23. BROOKS, W. K.: Development of Crustacea. (Read by title.)

ELECTIONS.

The election of officers, for a term of 6 years, took place on Wednesday, April 17, 1889, and resulted as follows:

President, Prof. O. C. MARSH.
Vice-President, Prof. S. P. LANGLEY.
Home Secretary, Prof. ASAPH HALL.

The following members were selected for the council for the ensuing year: Messrs. G. J. Brush, B. A. Gould, M. C. Meigs, S. Newcomb, Ira Remsen, and F. A. Walker.

RECOMMENDATIONS FROM THE COUNCIL.

The following recommendations from the council were adopted by the Academy:

1. That the assessment for the ensuing year be $5.

2. That the proposed changes in the deeds of trust of the Draper and Smith funds, authorized by the resolution adopted last year, be indefinitely postponed.

HOME SECRETARY'S REPORT.

The home secretary submitted the following report for the past year:

April 16, 1889.

The current business of the Academy has been carried on as in former years.

The printing of the memoirs has made some progress. Part I of Vol. IV has been printed, but owing to delay in getting the plates only one hundred and seventy-seven copies were delivered to the Academy. These have been nearly all distributed to members and foreign associates. The printing of Part II of Vol. IV has not been begun on account of delay with the drawings. The drawings are now completed, and the printing of Part II will begin soon.

In accordance with the direction of the council, the printing of the third volume of biographical memoirs was begun a year ago, and the memoirs of William B. Rogers, Edward Tuckerman, Edward B. Hunt, James C. Watson, and James B. Eads, have been printed. These memoirs make seventy-nine pages of print. Five hundred copies have been struck off, and are held by the printers, Judd & Detweiler, until the volume is completed.

The annual of the Academy referred to in Rule XII has been understood to mean the constitution, rules, and list of members, and has been issued each year. The cost of printing and distributing this annual is about $40 a year. The publication of this matter again in the annual report of the president has been thought by some of the members to render the annual unnecessary, but the secretary has not thought himself at liberty to discontinue it.

REPORTS OF COMMITTEES.

Mr. Gibbs, for the committee on the election of foreign associates, submitted a report recommending the election of Lieut. Gen. Don Carlos Ibañez, director of the Geodetic Survey and the Census of Spain, and president of the international committee of weights and measures. The foreign secretary was authorized to cast the vote of the Academy for that gentleman, who was declared elected.

At Mr. Langley's request, the committee on reserving public lands on and near Mount Whitney, California, for scientific purposes, was continued.

The home secretary, for the committee on publication, made a statement concerning the printing of the memoirs, and expressed the hope that the style of printing might be improved in the future.

Mr. Gill, representing the committee on publications of the Academy, reported progress.

The president and Mr. Coffin made statements concerning the action of the committee on the relation of the Academy to the Government.

The board of direction of the Bache fund presented a report, which was read by Mr. Gibbs and accepted. (See Appendix D, p. 37.)

Mr. Newcomb submitted the report of the board of trustees of the Watson fund. This report was accepted. (See Appendix D, p. 48.)

THE JAMES WATSON MEDAL.

At a public session of the Academy, held on the evening of April 17, 1889, the second James Watson gold medal and the sum of $100 in gold were presented to Prof. Edward Schönfeld, director of the Bonn Observatory, Germany.

At the same session, a biographical memoir of the late Prof. Spencer F. Baird was read by Dr. Billings.

NEW MEMBERS.

At this meeting, the following new members were elected: Prof. Lewis Boss, Prof. Charles S. Hastings, Prof. Arthur Michael, Prof. Sereno Watson, and Prof. Charles A. White.

NEW FOREIGN ASSOCIATE.

Lieut. Gen. Don Carlos Ibañez, of Madrid, Spain, was elected foreign associate of the Academy.

TREASURER'S REPORT.

WASHINGTON, D. C., *April* 16, 1889.

SIR: The committee appointed to audit the treasurer's accounts and to compare them with the report made by the committee upon the securities held by the Academy respectfully report that they have examined the books and the accounts of the treasurer, and that they have compared the vouchers with the disbursements reported, and have compared the receipts with the record of dues received from members and with the record of interest received from invested funds of the Academy, and find the same to be correct.

IRA REMSEN.
S. C. CHANDLER.
G. W. HILL.
Committee.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

REPORT.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences.

1. *General fund.*

Balance brought forward from April 17, 1888	$213.56	
Received during year	503.26	
Total to be accounted for		$716.82
Disbursements during year		306.05
Balance cash on hand		410.77

Available balances = *$377.77 + $500 in 3.65 bonds.

2. *Bache fund.*

Balance brought forward from April 17, 1888	$1,648.82	
Received during year	†3,985.73	
Total to be accounted for		$5,634.55
Disbursements during year		2,133.60
Balance cash on hand		3,500.95

Available balance = ‡ $11.05.

3. *Watson fund.*

Balance brought forward from April 17, 1888	$2,197.05	
Received during year	836.74	
Total to be accounted for		$3,033.79
Disbursements during year		†2,735.40
Balance cash on hand		298.39

Available balances = § $198.39 + $1,500 in 3.65 bonds.

4. *Draper fund.*

Balance brought forward from April 17, 1888	$565.64	
Received during the year	200.00	
Total to be accounted for		765.64
Disbursements during the year		35.33
Balance cash on hand		740.31

Available balances = $480.31 + $260 reserve.

* $33 due secretary from general fund.

† Includes transfer of $1,500 District of Columbia 3.65 bonds to Watson fund.

‡ $36 due Bache fund from Philadelphia City bond.

§ 100 due to accompany Watson medal.

5. *Smith fund.*

Balance brought forward from April 17, 1888	$939.10	
Received during year	324.00	
Total to be accounted for		$1,263.10
Disbursements during year		25.32
Balance cash on hand		1,237.78

Available balances = $705.78 + $532 reserve.

A detailed account current, with vouchers, is herewith submitted.

Very respectfully,

J. W. BILLINGS,
Treasurer, National Academy of Sciences.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

REPORT ON SECURITIES.

The following report of the committee to examine securities held by the Academy was read and approved:

WASHINGTON, D. C., *April* 16, 1889.

SIR: The committee appointed to inspect and verify the bonds and securities and other property of the National Academy begs leave to report that it has performed that duty on April 11, 1889.

The bonds and securities of the Academy at present deposited by its treasurer at the Washington Safe Deposit Company's office, 916 Pennsylvania avenue, were inspected and verified individually, and were found to correspond to the list in the treasurer's book.

1. *Bache trust fund.*

United States 4½ per cent. registered bonds	$42,100	
United States 4 per cent. registered bonds	3,850	
City of Davenport 6 per cent. loan	1,000	
City of Philadelphia 6 per cent. loan	600	
Total Bache fund		$47,550

Also, land warrant No. 62740 for 160 acres of land in Missouri.

2. *Joseph Henry fund.*

An agreement with the Pennsylvania company for insurance on lives and granting annuities as to the final disposition of the Joseph Henry fund of $40,000.

3. *Watson trust fund.*

United States 4½ per cent. registered bonds	$6,200	
United States 4 per cent. registered bonds	850	
Certificates of stock of Michigan Mutual Life Insurance Company	6,700	
Total Watson fund		13,750

4. *Henry Draper medal fund.*

United States 4 per cent. registered bonds	5,000

Also, a deed of trust of Mary Anna Palmer Draper, giving $6,000 to the *Academy.*

5. *J. Lawrence Smith medal fund.*

United States 4½ per cent. registered bonds $7,200
Also a deed of trust of Sarah Julia Smith, giving $8,000 to the Academy.

6. *Income of the Bache and general fund.*

District of Columbia 3.65 bonds 2,000
Of this, $1,500 belongs to the income of the Watson fund, and $500 to the income of the general fund.

Total of securities held by the Academy 75,500

For the convenience of the auditing committee, a detailed statement of every bond and security, as found by your committee, is herewith inclosed.

Respectfully submitted by,

CHARLES A. SCHOTT.
THEODORE N. GILL.
Committee.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

ADDRESS BY THE PRESIDENT.

The president made a short address, in which he spoke of the policy of the Academy, its relations to the Government in the past, and the proper action for the future.

DEATH OF MEMBERS.

The president announced the death of Dr. J. C. Dalton, who died February 2, 1889.

Dr. S. Weir Mitchell was appointed to prepare a biographical notice.

The president also announced the death of two foreign associates, Dr. R. Clausius, of Bonn, and Professor Chevreul, of Paris.

INVITATIONS.

The members of the Academy were invited to attend the meeting of the Anthropological Society, Tuesday evening, April 16.

The President of the United States received the members of the Academy, Wednesday, April 17, at 12 o'clock.

The Secretary of the Smithsonian Institution extended an invitation to each member of the Academy and family to attend a reception at the Institution on Thursday evening, April 18, at half past 8 o'clock.

The hospitalities of the Cosmos Club were extended to the members of the Academy during their stay in Washington.

The Academy adjourned April 19, to meet in Philadelphia, November 12, 1889.

SCIENTIFIC SESSION.

HELD IN PHILADELPHIA, NOVEMBER 12 TO 14, 1889.

A scientific session, for the reading of papers only, having been called by the council, as announced at the April meeting, the Academy met at the University of Pennsylvania, Philadelphia, on November 12, 1889.

The president, Prof. O. C. Marsh, presided at this meeting.

The following members were present during the session:

Barker.	Gill.	Mendenhall.	Rood.
Billings.	Gould.	Michael.	Rowland.
Brewer.	Hall, A.	Michelson.	Sellers.
Brooks.	Hall, J.	Mitchell, S. W.	Wood.
Chandler, C. F.	Langley.	Newberry.	Wright.
Cope.	Leidy.	Newcomb.	Young.
Gibbs, W.	Lesley.	Powell.	
Gilbert.	Marsh.	Pumpelly.	

The following papers were read and discussed:

1. LANGLEY, S. P.: On the Economy of Energy in the Glow-worm. Discussed by Messrs. W. Gibbs, Langley, Barker, C. F. Chandler, and Rood.
2. ROOD, O. N.: On Photometry of Colored Light. Discussed by Messrs. Langley, Young, and Rood.
3. GIBBS, W.: On certain Pyrophosphates. Discussed by Mr. Barker.
4. COPE, E. D.: On the Vertebrata of the Miocene of the Cypress Hills of Canada.
5. HALL, A.: On Saturn and its Rings. Discussed by Messrs. Rood, Gibbs, Young, Langley, and Hall.
6. GIBBS, W., and HARE, H. H.: On the Results of the Systematic Study of the Action of Definitely related Chemical Compounds upon Animals. (Read by Dr. Hare.) Discussed by Mr. Gibbs.
7. BARKER, G. F.: On Zinc Storage Batteries. Discussed by Mr. C. F. Chandler.
8. MICHELSON, A. A.: On Relative Wave-lengths. Discussed by Messrs. Rowland, Gould, and Michelson.
9. PICKERING, E. C.: On the Spectrum of Zeta Ursæ Majoris. (Read by Mr. G. F. Barker.)
10. RYDER, J. A.; presented by T. Gill: On the Persistence and Meaning of the Bi-concave centrum of the Vertebræ of Vertebrates. Discussed by Messrs. Gill and Ryder and the President.
11. BROOKS, W. K.: On the Early Stages of Echinoderms. Discussed by Messrs. Gill and Brooks.
12. GILL, T: On a Peculiar Ordinal Modification as Exemplified by Fishes of the Family Halisauridæ.
13. GOULD, B. A.: On the New Prototypes of the Kilogramme and the Metre. Discussed by Messrs. Newcomb, Rowland, and Gould.
14. HALL, J.: Remarks upon the Present State of our Knowledge in Reference to a Revision of the Genera of Brachiopoda for the Palæontology of New York, Vol. VIII.
15. BREWER, W. H.: On the Heredity of Acquired Characters. Discussed by Messrs. Wood, Brooks, Powell, Brewer, Gill, and Ryder.
16. MICHAEL, A.: On the "Positive-negative" Hypothesis in its Application to Organic Chemistry.
17. NEWCOMB, S.: On the Results of the Transits of Venus observed in 1761 and 1769.
18. NEWCOMB, S.: On the Theory of Cosmical Temperature. Discussed by Mr. W. *Gibbs.*

19. POWELL, J. W.: On the Desert Ranges.
20. WOOD, H. C.: On Hypnotic Cases without Suggestion. Discussed by Messrs. Newcomb and Wood.
21. NEWBERRY, J. S.: On the Laramie Group. Discussed by Messrs. Powell and Newberry.
22. MARSH, O. C.: On the Skull of the Gigantic Ceratopsidæ. Discussed by Mr. Newberry.
23. MARSH, O. C.: On American Mesozoic Mammals. Discussed by Messrs. Gill and Marsh.

DEATH OF MEMBERS.

The president announced the deaths of Prof. F. A. P. Barnard, Prof. George H. Cook, Prof. Elias Loomis, and Prof. Leo Lesquereux, and appointed Prof. O. N. Rood, Prof. J. S. Newberry, Prof. H. A. Newton, and Prof. J. Peter Lesley, respectively, to prepare the biographical notices.

The president also announced the death of Mr. James P. Joule, of England, a foreign associate of the Academy.

Notice was given by the president that memoirs for the next volume, ready for publication must be sent in by December 1, 1889.

The scientific session then adjourned to meet in Washington on the third Tuesday in April, 1890.

SPECIAL SESSION.

HELD IN PHILADELPHIA, NOVEMBER 13, 1889.

A special session of the Academy having been called by the council, in accordance with Article III, section 1, of the constitution, the Academy met at the University of Pennsylvania, Philadelphia, November 13, 1889, the president, Prof. O. C. Marsh, presiding.

The president laid before the Academy the purpose of the present business session, which was the consideration of his annual report to Congress. He said that this report would contain both the deeds of gift and an account of the grants made from the trust funds of the Academy since these funds were received.

RECOMMENDATIONS.

The home secretary read the recommendation of the council that the president's annual report be approved by the Academy, and that the president be authorized to include in this report the proceedings of the present meeting, as well as those of the last April session.

This recommendation was adopted by the Academy.

Mr. George F. Barker presented the following recommendation of the committee on the Henry Draper medal:

The committee on the Henry Draper medal recommend to the National Academy of Sciences the award of the Henry Draper medal to Prof. Henry A. Rowland, of Baltimore, for his researches *on the solar* spectrum.

This recommendation was adopted by the Academy.

NOMINATIONS.

Five nominations for membership in the Academy were read by the home secretary. These will be acted on at the April meeting, 1890.

RESOLUTIONS.

Mr. W. Gibbs presented the following resolutions, which were adopted by the Academy:

Resolved, That the Academy tender to the provost, trustees, and faculty of the University of Pennsylvania their grateful acknowledgments for the abounding hospitality with which they have been received, and for the ample facilities provided for their meetings.

Resolved, That the Academy cordially thank the Historical Society of Pennsylvania for the reception so gracefully offered, and which afforded the Academy an opportunity to make the acquaintance of the members of one of the most distinguished historical associations in our country.

The special session then adjourned.

Respectfully submitted.

O. C. MARSH,
President of the National Academy of Sciences.

APPENDICES.

APPENDIX A.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. LeConte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation *hereby constituted* shall have power to make its own

organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March three, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June* 10, 1882.

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June* 24, 1884.

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

APPENDIX B.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875, April 21, 1881, April 19, 1882, April 18, 1883, and April 19, 1888.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States, on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution of the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its session next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special meetings may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election for officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected, and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he received two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president, and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author, or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be, at all times, at the disposition of the Government, upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receives two-thirds of the votes cast, it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the member were present.

RULES.

I. In the absence of any officer, a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented; which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year, and referred with the accounts to the auditing committee.

IV. A committee of arrangements consisting of five members shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members; to arrange the business of each day; to receive the titles of papers, reports, etc.; and to arrange the order of reading, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to fix the length of time to be devoted to reading of all papers submitted, and to limit the time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows :

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.
8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings shall be convened at noon.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session. But no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date in the records of the Academy from the date of their presentation to the Academy, and the order of their presentation shall be that in which they were registered, unless changed by consent of the author.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred, at the meeting at which they

are read, to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. An annual of the Academy shall be prepared and published by the secretaries.

XIII. The printing of the Academy shall be under the charge of the committee of publication, to consist of the home secretary and four other members to be named by the president with the advice and consent of the council.

XIV. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XVI. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVII. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVIII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XIX. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XX. At least 60 days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XXI. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXII. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXIII. Any rule of the Academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, *ex officio*, a member of all Government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1889.

	Expiration of term.
MARSH, O. C., *President*	April, 1895
LANGLEY, S. P., *Vice-President*	April, 1895
GIBBS, WOLCOTT, *Foreign Secretary*	April, 1892
HALL, A., *Home Secretary*	April, 1895
BILLINGS, JOHN S., *Treasurer*	April, 1893

ADDITIONAL MEMBERS OF COUNCIL, 1889-'90.

BRUSH, G. J.
GOULD B. A.
MEIGS, M. C.
NEWCOMB, S.
REMSEN, IRA.
WALKER, F. A.

COMMITTEES OF THE ACADEMY.

On Ways and Means to Provide a Fund for the Academy.

ROGERS, FAIRMAN, *Chairman.*
CHANDLER, C. F.
MARSH, O. C.
MITCHELL, S. WEIR.
PUMPELLY, R.

On Weights, Measures, and Coinage.

GIBBS, WOLCOTT.
HILGARD, J. E.
MEIGS, M. C.
NEWCOMB, S.
NEWTON, H. A.
PEIRCE, C. S.
TROWBRIDGE, W. P.

On the Election of Foreign Associates.

GIBBS, WOLCOTT, *Chairman.*
DANA, J. D.
GOULD, B. A.
HALL, A.
NEWCOMB, S.

On Reserving Public Lands on and near Mount Whitney, California, for Scientific Purposes.

LANGLEY, S. P., *Chairman.*
BREWER, W. H.
POWELL, J. W.

On Publication.

THE HOME SECRETARY.
BILLINGS, J. S.
COFFIN, J. H. C.
NEWCOMB, S.
POWELL, J. W.

On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.
COFFIN, J. H. C.
HILGARD, J. E.
MEIGS, M. C.
POWELL, J. W.

TRUST FUNDS.

Board of Direction of the Bache Fund.

DANA, J. D.
HILGARD, J. E.
GIBBS, W.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.*
COFFIN, J. H. C.
GOULD, B. A.

The Henry Draper Fund.

BARKER, G. F., *Chairman.*
NEWCOMB, S.
GIBBS, W.
WRIGHT, A. W.
YOUNG, C. A.

The J. Lawrence Smith Fund.

GIBBS, WOLCOTT, *Chairman.*
HALL, A.
BRUSH, G. J.
PUMPELLY, R.
RUTHERFURD, L. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY, 1890.

		Date of Election.
ABBE, CLEVELAND	*Washington, D. C.*	1879
ABBOTT, HENRY L., U. S. A	*Army Building, New York City.*	1872
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	3909 *Locust St., Philadelphia, Pa.*	1876
BARTLETT, WILLIAM H. C	75 *Locust Hill Ave., Yonkers, N. Y.*	——
BELL, A. GRAHAM	*Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*Washington, D. C.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Cambridge, Mass.*	1887
BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BROWN-SEQUARD, CHARLES E	*Paris, France.*	1868
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	16 *Craigie St., Cambridge, Mass.*	1888
COMSTOCK, CYRUS B., U. S. A	*Whitestone, Long Island, N. Y.*	1884
COOKE, JOSIAH P	*Cambridge, Mass.*	1872
COPE, EDWARD D	2100 *Pine St., Philadelphia, Pa.*	1872
COUES, ELLIOTT	*Washington, D. C.*	1877
CRAFTS, JAMES M	*École des Mines, Paris, France.*	1872
DANA, EDWARD S	*New Haven, Conn.*	1884
DANA, JAMES D	*New Haven, Conn.*	——
DAVIDSON, GEORGE	*San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Washington, D. C.*	1884
FARLOW, W. G	*Cambridge, Mass.*	1879
FERREL, WILLIAM	1641 *Broadway, Kansas City, Mo.*	1868
GENTH, FREDERICK A	*W. Philadelphia, Pa.*	1872
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOODE, G. BROWN	*Washington, D. C.*	1888
GOULD, BENJAMIN A	*Cambridge, Mass.*	——
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH, U. S. N	*Washington, D. C.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Oakland, Cal.*	1872
HILGARD, JULIUS E	*Washington, D. C.*	——
HILL, GEORGE W	*Washington, D. C.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*San José, California.*	1885
HUNT, T. STERRY	*Montreal, Canada.*	1873

		Date of Election.
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*New Haven, Conn.*	1866
KING, CLARENCE	62 *Cedar St., New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LEIDY, JOSEPH	*Philadelphia, Pa.*	1884
LESLEY, J. PETER	1008 *Clinton St., Philadelphia, Pa.*	——
LECONTE, JOHN	*Berkeley, Cal.*	1878
LECONTE, JOSEPH	*Berkeley, Cal.*	1875
LOVERING, JOSEPH	*Cambridge, Mass.*	1873
MARSH, O. C	*New Haven, Conn.*	1874
MAYER, ALFRED M	*Hoboken, N. J.*	1872
MEIGS, MONTGOMERY C., U. S. A	*Washington, D. C.*	1865
MENDENHALL, THOMAS C	*Washington, D. C.*	1887
MICHAEL, ARTHUR	*Somerville, Mass.*	1889
MICHELSON, ALBERT A	*Worcester, Mass.*	1888
MITCHELL, HENRY	*Boston, Mass.*	1885
MITCHELL, S. WEIR	1524 *Walnut St., Philadelphia, Pa.*	1865
MORSE, EDWARD S	*Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWBERRY, J. S	*New York City.*	——
NEWCOMB, SIMON, U. S. N	*Washington, D. C.*	1869
NEWTON, H. A	*New Haven, Conn.*	——
NEWTON, JOHN, U. S. A	*New York City.*	1876
OLIVER, JAMES E	*Ithaca, N. Y.*	1872
PACKARD, A. S	*Providence, R. I.*	1872
PIERCE, CHARLES S	*U. S. Coast Survey, Washington, D. C.*	1877
PETERS, C. H. F	*Clinton, N. Y.*	1876
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs Ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	147 *S. Fourth St., Philadelphia, Pa.*	——
ROGERS, WILLIAM A	*Waterville, Me.*	1885
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
RUTHERFURD, LEWIS M	175 *Second Ave., New York City.*	——
SCHOTT, CHARLES A	*Washington, D.C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	1609 *Hamilton St., Philadelphia, Pa.*	1873
SMITH, SIDNEY I	*New Haven, Conn.*	1864
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
TROWBRIDGE, WILLIAM P	*New York City.*	1872
TRUMBULL, J. H	*Hartford, Conn.*	1872
VERRILL, A. E	*New Haven, Conn.*	1872
WALKER, FRANCIS A	*Boston, Mass.*	1878
WATSON, SERENO	*Cambridge, Mass.*	1889
WHITE, CHARLES A	*Washington, D. C.*	1889
WOOD, HORATIO C	1925 *Chestnut St., Philadelphia, Pa.*	1-79
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

HONORARY MEMBERS.

AGASSIZ, ALEXANDER ..... *Cambridge, Mass.*
LONGSTRETH, MIERS F ..... *Derby, Pa.*
LYMAN, THEODORE ..... *Brookline, Mass.*

DECEASED MEMBERS.

	Date of Death.
*AGASSIZ, LOUIS	Dec. 14, 1873
*ALEXANDER, J. H	March 2, 1867
*ALEXANDER, STEPHEN	June 25, 1883
*BACHE, ALEXANDER DALLAS	Feb. 14, 1867
*BAIRD, SPENCER F	Aug. 19, 1887
BARNARD, J. G	May 14, 1882
BARNARD, F. A. P	April 27, 1889
*CASWELL, ALEXIS	Jan. 8, 1887
*CHAUVENET, WILLIAM	Dec. 13, 1870
*CLARK, HENRY JAMES	July, 1, 1873
COFFIN, JAMES H	Jan. 6, 1873
COFFIN, JOHN H. C	Jan. 9, 1890
COOK, GEORGE H	Sept. 22, 1889
DALTON, J. C	Feb. 2, 1889
DAVIS, CHARLES H	Feb. 18, 1877
*DRAPER, HENRY	Nov. 20, 1882
*DRAPER, JOHN W	Jan. 4, 1882
*EADS, JAMES B	Mar. 8, 1887
ENGELMANN, GEORGE	Feb. 11, 1884
*FRAZER, JOHN FRIES	Oct. 12, 1872
*GABB, WILLIAM M	May 30, 1878
*GILLISS, JAMES MELVILLE	Feb. 9, 1865
*GOULD, AUGUSTUS A	Sept. 15, 1866
*GRAY, ASA	Jan. 30, 1888
*GUYOT, ARNOLD	Feb. 8, 1884
HAYDEN, F. V	Dec. 22, 1887
*HENRY, JOSEPH	May 13, 1878
*HADLEY, JAMES	Aug. 1, 1864
*HITCHCOCK, EDWARD	Feb. 27, 1864
*HOLBROOK, J. E	Sept. 8, 1871
*HUBBARD, J. S	Aug. 16, 1863
*HUMPHREYS, A. A	Nov. 28, 1883
*HALDEMAN, S. S	Sept. 10, 1880
*KIRTLAND, JARED P	Dec. 10, 1877
*LANE, J. HOMER	——, 1880
*LECONTE, JOHN L	Nov. 15, 1883
LESQUEREUX, LEO	Oct. 25, 1889
LOOMIS, ELIAS	Aug. 16, 1889
*MAHAN, D. H	Sept. 16, 1871
*MARSH, G. P	July 23, 1882
*MEEK, F. B	Dec. 21, 1877
*MORGAN, LEWIS H	Dec. 14, 1881
*NORTON, WILLIAM A	Sept. 21, 1883
*POURTALES, L. F	July 17, 1880
RODGERS, JOHN	May 5, 1882
ROGERS, ROBERT E	Sept. 7, 1884
*ROGERS, WILLIAM B	May 30, 1882
*SAXTON, JOSEPH	Oct. 26, 1873
*SILLIMAN, BENJ., SR	Nov. 24, 1864

	Date of Death.
SILLIMAN, BENJ., JR	Jan. 14, 1885
*SMITH, J. LAWRENCE	Oct. 12, 1883
*STIMPSON, WILLIAM	May 26, 1873
*STRONG, THEODORE	Feb. 1, 1869
*SULLIVANT, W. S	April 30, 1873
*TORREY, JOHN	March 10, 1873
*TOTTEN, J. G	April 22, 1864
*TUCKERMAN, EDWARD	March 15, 1886
*WARREN, G. K	Aug. 8, 1882
*WATSON, JAMES C	Nov. 23, 1880
*WINLOCK, JOSEPH	Jan. 11, 1875
*WOODWARD, J. J., U. S. A	Aug. 17, 1884
WORTHEN, A. H	May 6, 1888
*WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

BUNSEN, ROBERT W	*Heidelberg.*
AIRY, SIR GEORGE B	*Greenwich.*
OWEN, SIR RICHARD	*London.*
BURMEISTER, C. H. C	*Buenos Ayres.*
STRUVE, OTTO VON	*Pulkova.*
ADAMS, J. C	*Cambridge.*
CAYLEY, ARTHUR	*Cambridge.*
HELMHOLTZ, BARON H. VON	*Berlin.*
PASTEUR, LOUIS	*Paris.*
STOKES, SIR GEORGE G	*Cambridge.*
SYLVESTER, J. J	*Oxford.*
HOOKER, SIR J. D	*Kew.*
THOMSON, SIR WILLIAM	*Glasgow.*
AUWERS, ARTHUR	*Berlin.*
BERTRAND, J. L. F	*Paris.*
HUXLEY, T. H	*London.*
VIRCHOW, RUDOLPH VON	*Berlin.*
BERTHELOT, M. P. E	*Paris.*
DE CANDOLLE, ALPHONSE	*Geneva.*
KÖLLIKER, ALBERT VON	*Würzburg.*
RICHTHOFEN, F. VON	*Berlin.*
HOFMANN, A. W	*Berlin.*
IBAÑEZ, CARLOS	*Madrid.*

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.	MICHEL CHASLES.
CARL ERNST VON BAER.	SIR RODERICK I. MURCHISON.
HENRY MILNE-EDWARDS.	VICTOR REGNAULT.
MICHAEL FARADAY.	H. W. DOVE.
L. ELIE DE BEAUMONT.	C. A. F. PETERS.
SIR DAVID BREWSTER.	JUSTUS VON LIEBIG.
G. A. A. PLANA.	ALEXANDER BRAUN.
F. W. A. ARGELANDER.	JOACHIM BARRANDE.
FRIEDRICH WÖHLER.	ADOLPHE WÜRTZ.
J. B. DUMAS.	THEODORE VON OPPOLZER.
J. B. J. D. BOUSSINGAULT.	G. R. KIRCHOFF.
M. E. CHEVREUL.	RUDOLPH CLAUSIUS.

JAMES P. JOULE.

* Biographical notices have been presented of those designated by a *.

APPENDIX D.

TRUST FUNDS OF THE ACADEMY.

The National Academy of Sciences has been authorized by Congress to hold trust funds, and up to the present time, five gifts of importance have been received. The proceeds of four of these are available, and have already rendered much aid in promoting original research in science. The increasing usefulness of these various gifts makes it desirable to place together on record the orignal instruments of trust, and an account of the grants made from these funds since they were received by the Academy.

THE BACHE FUND.

The first important gift received by the Academy was from its first president, Alexander Dallas Bache, who left the greater part of his property in trust to the Academy, at his death in 1867. The income of the fund has been available for about 18 years, and the special grants made are stated in the report which follows the various instruments of gift relating to the trust.

EXTRACT FROM THE WILL OF ALEXANDER DALLAS BACHE.

March 18, 1862.

Item: As to all the rest and residue of my estate, including the sum of $5,000 placed at the disposal of my wife in case she should not desire to make any disposition of the same, I direct my executors hereinafter named to apply the income thereof, after the death of my wife, according to and under the direction of Joseph Henry, of Washington, Louis Agassiz and Benjamin Peirce, of Harvard College, Massachusetts, to the prosecution of researches in physical and natural science by assisting experimentalists and observers in such manner and in such sums as shall be agreed upon by the three above-named gentlemen, or any two of them, whom I constitute a board of direction for the application of the income of my residuary estate for the above objects after the death of my said wife. The class of subjects to be selected by this board and the results of such observations and experiments to be published at the expense of my trust estate under their directions out of the income thereof but without encroaching on the principal.

In case of the death or inability to act of all or any of the three gentlemen I have named, in my wife's lifetime, my will is that she shall supply their places in the board of direction by an instrument of writing, either testamentary or otherwise, desiring that, in the selection of the persons to administer the income of the trust fund hereby created, she will have regard to the selection of persons whose attention has been directed to the same branches of science as those I have named, and so that each of

the departments of physics, mathematics, and natural history shall be represented in the board. In case of any vacancy occurring in the board of direction after its organization, and after the death of my wife, by reason of the death, inability, or refusal to act, or resignation of any of its members, my will is that the surviving or remaining member or members, for the time being, shall have power to fill vacancies so occurring in the board by the selection of other person or persons to fill such vacancies, and so on from time to time as vacancies occur. My intention being that the board of direction shall have power to continue its existence, and to filling all vacancies occurring in their body from time to time, I direct that a minute of their proceedings be kept, and that the appointment of any member by the board shall be notified in writing to the trustees, for the time being, of my residuary estate. In the event of any failure of the board, for the time being, to direct the application of the income of my said residuary estate, or to continuing its existence by filling vacancies occurring in their body, my will is that the application of the income thereof for the purposes and objects declared in this clause of my will shall be made by the trustees, under the direction of the American Philosophical Society of Philadelphia.

* * * * * * *

Item: I hereby nominate and appoint my friends, Peter McCall, esq., and Morton P. Henry, esq., of the city of Philadelphia, and the survivor of them, to be the executors of and trustees under this my last will and testament.

CODICIL, JULY 15, 1863.

Item: I give and devise to my sister, Sally Franklin Wainwright, the house purchased by me, situated No. 396 West Twentieth Street, in the city of Washington, between G and H streets, to be held and enjoyed by her during the term of her natural life. After her death I direct the said house shall pass with the residue of my estate (subject to a life estate of my wife, Nancy Clarke Bache, therein, in case she should survive my sister) to the "National Academy of Sciences," upon the trusts set forth as to the said residue of my estate.

* * * * * * *.

Item: My will is that, upon the death of my wife, all the rest and residue of my estate shall be paid over to and vest in the corporation of the National Academy of Sciences, incorporated by act of Congress, passed the 3d day of March, A. D. 1863, whom I hereby appoint trustees in the place of my said executors under the fourth clause of my said will, to apply the income, according to the directions in the said clause contained, to the prosecution of researches in physical and natural science by assisting experimentalists and observers in such manner and in such sums as shall be agreed upon by the board of direction in the said clause named. My will further is, that, in case of any failure of the board for the time being to direct the application of the income of my residuary estate, or to continue its existence by filling vacancies occurring in their body, the application of the income thereof for the purposes and objects declared in the said clause shall be made under the direction of the National Academy of Sciences instead of the American Philosophical Society, of Philadelphia. In all other respects the said application of the income to the purposes aforesaid to be made by the same persons and under the same rules as I have prescribed in the said clause of my will.

Duly sworn to before Samuel Lloyd, February 27, 1867, in the city and county of Philadelphia.

BACHE TRUST FUND.

By the above will of Prof. A. D. Bache, his property, after the death of Mrs. Bache, passes to the National Academy of Sciences as a trust fund, the income of which is to be applied to the prosecution of

researches in physics and natural science, in such manner as shall be agreed upon by the board of direction, appointed by the fourth clause of his will. On the death of Mrs. Bache, which occurred in February, 1870, the executors proceeded to settle the estate. After paying various legacies, the amount of the trust fund was about $41,250.

The treasurer was given full power, by a vote of the Academy, to receive the trust fund and to act as attorney in fact for the Academy in all matters pertaining thereto. At his own suggestion, he was also required to give bonds for the faithful discharge of his duty in the sum of $50,000.

It was resolved that the whole fund should be invested in United States securities as early as practicable.

THE LAST WILL AND TESTAMENT OF NANCY CLARKE BACHE.

I hereby, in pursuance and exercise of the power of appointment contained in the last will and testament of my husband, Alexander Dallas Bache, devise, bequeath, and appoint the sum of five thousand dollars of the principal of the estate of my said husband, over which I have a power of appointment by his will, to be paid by his executors, or by such person or persons as shall hold the principal of the estate at my death, to my nephew, Henry Wood Bache, absolutely; and I hereby request my nephew, in case he should die unmarried and without issue, to make such a disposition of this amount by will as will secure it to be paid at his death to the National Academy of Sciences, at Washington, to be held by that corporation upon the same trusts and for the same purposes as are declared by my husband in his will, as to the residue of his estate after my death. I expressly desire, however, that it shall be understood that this request shall not be construed into any direction which would interfere with his full control of the principal, which is to be paid into his hands directly.

Second. I hereby direct the house, No. 1624 Chestnut street, in which I now reside, to be sold by my executor hereinafter named, within a reasonable time after my death, either at public or private sale, and after deducting from the purchase money any debts or expenses connected with the sale, and the administration of my estate, which, with the cash on hand or other property which I may own or possess at my death, shall be sufficient to satisfy, I direct my executor to pay over the net proceeds to the National Academy of Sciences, at Washington, to be held by that corporation as trustees in trust to apply the income thereof to the prosecution of researches in physical and natural science, according to the directions contained in the last will and testament of my husband as to the residue of his estate after my death in the same manner as if all the directions contained in the last will and testament of my husband and in the codicil thereto were herein repeated at length; my object being to make precisely the same disposition of the proceeds of this house as was made by my husband of his residuary estate after my death.

Third. I direct all the medals and diplomas of my husband, and the large photograph of him now in my possession, to be deposited and remain with the National Academy of Sciences. I have made a memorandum of the disposition of certain other articles which I desire shall be carried into effect as if contained in this will. I appoint Morton P. Henry, of Philadelphia, executor of this my last will and testament.

CODICIL TO THE LAST WILL AND TESTAMENT OF NANCY CLARKE BACHE, DATED APRIL 19, 1869.

Item: I hereby direct my executor to pay out of the proceeds of the sale of my said house, No. 1624 Chestnut street, Philadelphia, which I have directed to be sold, the sum of five hundred dollars to my nephew, Henry Wood Bache, for his own use and

benefit. I further direct my executor to invest five thousand dollars of the proceeds of sale of said house in his own name, as trustee, in such securities as he may think proper, and to pay the income thereof to my nephew, Henry Wood Bache, during his natural life. After the death of my nephew, I direct that the principal of the said sum of five thousand dollars shall go to the National Academy of Sciences, at Washington, in trust for the same uses and purposes as are declared as to the proceeds of sale of said house by my said will. I expressly declare that the above bequests to Henry Wood Bache are in addition to the five thousand dollars I have appointed to him out of my husband's estate. *Item:* I give and bequeath to my faithful servant, Isabella Mallihan, the sum of one hundred dollars, to be paid to her out of the proceeds of sale of said house. *Item:* I give and bequeath to my sister-in-law, Mrs. Sophia A. Irwin, the sum of one thousand dollars, to be paid to her out of the proceeds of sale of my said house. *Item:* I desire my executor to permit my sister, Mrs. Littlefield, to occupy my house for six months after my death free of rent, if she should desire to do so, during which time it shall remain unsold. *Item:* I hereby declare that the balance of the proceeds of the sale of my said house shall go, after paying and providing for the above legacies, as is set forth and declared in my said will, which in all other respects I hereby republish and declare as my last will and testament.

Sworn and subscribed before John Campbell, deputy register, in the city and county of Philadelphia, January 20, 1870.

STATEMENTS REGARDING THE BACHE FUND.

In April, 1871, the treasurer, Mr. Fairman Rogers, announced that the proceeds of the estate left to the Academy by the late Prof. A. D. Bache, had been formally handed over to him by the executors; that these funds amounted to $40,515.07, together with an annual ground rent of $102, and some land in Missouri not now available; and that in conformity with the resolutions adopted by the Academy, he was converting the securities into United States bonds as soon as practicable, and had given bonds in the sum of $50,000.

In April, 1872, the treasurer made a financial report concerning the Bache trust fund, and stated that the annual income amounted at present to about $2,500 in gold. He presented his bond to the Academy, which was approved and placed in the custody of the president.

The president informed the Academy that the board of direction had made two appropriations; one for the promotion of a magnetic survey of the United States, under the direction of Mr. Hilgard, and one for investigations of sun spots, by Professor Winlock.

In April, 1876, Mr. Henry, on the part of the board of direction, gave a statement of appropriations made for the past year.

The treasurer submitted a report of the condition of the fund, showing that the available income balance was $2,426.97. Upon his suggestion, a resolution was adopted by the Academy, authorizing the sale of the ground-rent forming part of the assets.

In April, 1877, on motion it was—

Resolved, That all apparatus procured at the charge of the Bache fund for the use of investigators shall be duly receipted for by those to whom it is loaned, according to forms to be prescribed by the board of direction, and shall be returned to the

officer having charge of the property of the Academy whenever the investigation for which it was provided is completed, but that it shall at all times be held subject to the disposal of the Academy.

At a meeting of the Academy held in April, 1879, it was reported by the treasurer that, by the death of Henry Wood Bache, the Bache fund would be increased by the amount of $4,650, according to the terms of the will of Mrs. A. D. Bache.

It was therefore—

Resolved, That Fairman Rogers, treasurer, be authorized to receive from the trustees of Henry Wood Bache, under the will of Mrs. A. D. Bache, all cash and securities payable to the National Academy of Sciences in the settlement of his accounts as trustee, and that he be further authorized to execute all papers required in the transaction.

At the stated session, in April, 1884, Mr. Hilgard, on the part of the board of direction of the Bache fund, made a statement of the present condition of the fund, explaining the policy which had formerly guided the board, and the rules adopted by the present board, with the view to having the fund more directly applied to distinct objects, the results of which might be published as "Memoirs of the Bache Fund."

REPORT ON THE BACHE FUND.

At the session of the National Academy held at Washington in April, 1888, resolutions were passed calling upon the board of direction of the Bache fund to present a detailed report of their expenditures from the fund up to the present time. A wish was at the same time expressed that references should be given to memoirs and papers containing results obtained through the application of the fund.

The present report is intended to comply as far as possible with the request of the Academy. It is drawn, for the greater part, at least, from memoranda furnished by Prof. J. H. C. Coffin, from 1881 to 1887, treasurer of the Academy.

So far as can now be determined, it has from the beginning been the custom of the board of direction, in case of approval of any application for money from the Bache fund, to indorse their approval upon the application, and then to forward the application to the treasurer for payment.

When the present board came into office, formal rules were adopted requiring the production of proper vouchers for expenditures, and also making it necessary that the board of direction should be unanimous. For many years past, Prof. J. E. Hilgard, as the only member of the board residing in Washington, has been chairman of the board, and has conducted business directly with the treasurer. Applications for money have, it is believed, been most frequently made to him, but sometimes to the other two members of the board. The difficulty in making out an absolutely perfect list of all the appropriations made by the board arises from the fact, that the orders prior to April 19, 1884, were stolen

from the treasurer's box (together with all other vouchers) in the Academy room in the Smithsonian Institution. It is believed, however, that the list herewith furnished up to April, 1888, is nearly, if not quite complete. The list is as follows:

1871. Sept. 6, to Prof. J. E. Hilgard for the magnetic survey of the United States	$500.00
1872. Jan. 16, to Prof. J. E. Hilgard for the same	500.00
1872. Jan. 16, to Prof. Joseph Winlock for investigations of sun spots	400.00
1872. Apr. 29, to Prof. J. E. Hilgard for the magnetic survey of the United States	500.00
1872. July 20, to Prof. Joseph Winlock for investigations of sun spots	400.00
1872. Nov. 28, to Prof. J. E. Hilgard for magnetic survey of the United States	1,000.00
1873. Feb. 17, to Prof. Joseph Winlock for investigations in solar physics	1,200.00
1873. Nov. —, to Prof. J. E. Hilgard for magnetic survey	1,200.00
1874. Mar. 16, to Prof. Joseph Winlock for the same as No. 3	500.00
1874. June 15, to Prof. J. E. Hilgard for magnetic survey	1,200.00
1875. June 17, to Prof. J. E. Hilgard for magnetic survey	1,000.00
1875. Oct. 5, to Prof. J. E. Hilgard for magnetic survey	500.00
The magnetic survey of the United States made at the charge of the Bache fund was terminated in 1876. The results obtained up to that time were published in detail in the Coast Survey Report for 1882, Appendix 14, 106 pp., 4to. The money received by Professor Winlock was employed under his direction in observations of the sun, as described in the preface to vol. VIII of the Annals of the Observations of Harvard University, and the results were published in the second part of the same volume.	
1875. Oct. 25, to Charles S. Peirce	400.00
(Two grants, one of $1,200 for the study of color; one of $500 for the comparison of sensations.)	
1876. Apr. 28, to Prof. A. M. Mayer for acoustic researches	250.00
Professor Mayer's results are contained in the Memoirs of the National Academy of Sciences, vol. III, Part I, 1884.	
1876. May 24, to Prof. J. E. Hillgard for the magnetic survey of the United States	1,000.00
1876. Sept. 18, to Charles S. Peirce	400.00
1876. Nov. 18, to Prof. S. P. Langley	500.00
1876. Dec. 12, to Charles S. Peirce	400.00
1877. May 16, to Prof. Wolcott Gibbs for researches on the complex inorganic acids	100.00
1877. June 13, to Prof. A. M. Mayer for researches on the nature of the discharge of the inductorium	500.00
Memoirs Nat. Acad., vol. III, Part 1 (1884).	
1877. Oct. 5, to Prof. J. E. Hilgard for the magnetic survey of the United States. Computations of field work from 1871 to 1876	600.00
1877. October 22, to Prof. Wolcott Gibbs for researches on the complex inorganic acids	200.00
1877. Nov. 19, to Prof. S. P. Langley	500.00
1878. Sept. 30, to Charles S. Peirce	500.00

1878. Sept. 30, to C. R. Powalky, PH. D. $500.00
For a new reduction of La Caille's observations of fundamental stars in the southern heavens in 1749–1757. Published in the report of the Coast and Geodetic Survey for 1882, Appendix No. 21, 1879.
June 17, to R. W. Willson, treasurer Fort Worth eclipse party, to pay part of the expense of publishing the observations made by the party at Fort Worth, in July, 1878.
Published: "Report of the observations of the total solar eclipse, July 29, 1878, made at Fort Worth, Texas."

1879. Jan. 17, to Leonard Waldo for work on eclipse party 100.00
Report published by John Wilson & Son, Cambridge, and distributed to leading observatories and societies.

1879. May 10, to Samuel Hein (object not stated)..... 150.00

1879. May 20, to Prof. Wolcott Gibbs for work on complex inorganic acids. 300.00

1879. Aug. 2, to J. C. Watson (object not known)..... 1,000.00

1880. Feb. 17, to the American Journal of Science for magnetic maps 60.00

1880. Mar. 13, to Prof. C. S. Lyman, for the board of managers of the Yale observatory to aid the thermometric bureau of the observatory in purchasing standard thermometers and other instruments for its necessary equipment 500.00
Reports published: "Report of the Board of Managers of the Observatory of Yale University to the President and Fellows," 1880–'81 to 1887–'88.

1881. June 6, to Prof. S. P. Langley for observations on the physical constitution of the sun..... 1,000.00

1881. Dec. 9, to Prof. Wolcott Gibbs for work on complex inorganic acids.... 300.00
Dr. Gibbs's work on the complex inorganic acids is not yet completed. Five installments have been published in the Proceedings of the American Academy of Arts and Sciences, vols. XV, XVI, XVII, XVIII, XIX.

1882. July 14, to Prof. S. Newcomb for experiments on the velocity of light. 1,200.00
The results of this investigation were published in the astronomical papers of the American Ephemeries, vol. II, parts III and IV.

1883. Apr. 25, to Mr. Rockwell for the eclipse party..... 800.00

1883. June 6, to Mr. Rockwell for the eclipse party..... 600.00

1883. Nov. 27, to Prof. E. S. Holden for observations of the aurora borealis and zodiacal light..... 300.00

1883. Nov. 27, to Prof. E. S. Holden for the purchase of an aurora spectroscope, $300 (less $20.26 returned), $279.74. This instrument is now at the Washburn Observatory, Madison, Wis. In consequence of the removal of Professor Holden to California a short time after it was received, no work suitable for publication was done with it. Professor Holden refunded $20.26.

1884. Sept. 17, to Prof. S. P. Langley for observations on the physical constitution of the sun..... 1,500.00
Professor Langley's work has been done partly at the expense of the Bache fund, and partly at the expense of other funds, and his results have been published together so that a precise reference to what has been done with the Bache fund alone is not possible. We may, however, cite the following: American Journal of Science, August, 1887; Memoirs of the National Academy of Sciences for 1882, vol —; American Journal of Science for March, 1884; the same for January, 1886; the same for August, 1886.

1884. Oct. 22, to Prof. Ira Remsen for observations on the influence of magnetism upon chemical action $500.00

Two preliminary papers have been published in the American Chemical Journal, vol. VII, p. 430. A paper giving the complete results will soon be published in the American Chemical Journal.

1884. Nov. 6, to Prof. H. B. Hill for the study of pyromucic acid 200.00

The results of this work have been published in Leibig's Annalen, vol. CCXXXII, p. 42; in the Berichte der Deutschen Chem. Gesellschaft, XVIII, 2095; XX, 252; XX, 3359; and in the Proceedings of the American Academy of Arts and Sciences, XXI, 135; XXII, 315; XXIII, 188. Other papers are in press or nearly ready for publication.

1884. Nov. 20, to Prof. E. S. Holden for observations on 303 fundamental stars 400.00

1884. Dec. 4, to Dr. E. H. Hall for investigations in electricity 500.00

Results published in the August and October numbers of the American Journal of Science for 1888.

1884. Dec. 26, to W. M. Davis for observations on the motion of clouds as indicating upper currents 50.00

No published report has been made.

1885. March 26, to W. M. Davis for observations on thunder storms 200.00

1885. April 6, to Prof. E. S. Holden for observations on 303 fundamental stars 225.00

Professor Holden's work on the observations of fundamental stars appeared in the publications of the Washburn Observatory, vol. IV, 1885.

1885. May 1, to Prof. A. A. Michelson for work on the velocity of light.... 283.97

1885. June 11, to Prof. E. C. Pickering for observations on stellar photography 1,000.00

Professor Pickering's results have been published in the Memoirs of the American Academy of Arts and Sciences, XI, 179; XVIII, No. 4, of the Annals of Harvard College Observatory; in vol. XVIII, No. 6, of the same; and vol. XVIII, No. 8.

1885. July 2, to Prof. J. E. Hilgard for the magnetic survey of the United States. Supplementary work 50.00

1885. July 8, to Prof. J. E. Hilgard for same 150.00

1885. July 8, to Yale College Observatory for determination by A. Hall, jr., of the mass of Saturn 300.00

1885. Nov. 9, to Mr. A. G. Webster for an investigation of the mechanical equivalent of heat by an electric method..... 250.00

Nothing was accomplished by this work. The apparatus was forwarded to the treasurer at Washington, and $29.11 of the money refunded.

1885. Dec. 31, to Prof. E. C. Pickering for observations on stellar photography 1,000.00

1886. Feb. 27, to Yale College Observatory for determination by A. Hall, jr., of the mass of Saturn 300.00

1886. March 3, to the New England Meteorological Society for observations on thunder storms..... 300.00

1886. July 28, to Yale College Observatory for determination by A. Hall, jr., of the mass of Saturn 300.00

Mr. Hall, under Dr. Elkin's direction, made observations in 1885–1887, and has since that time been engaged in reducing the same. The details are not ready for publication, but the results of his work were communicated to the Academy at its meeting in April, 1889.

1886. Sept. 29, to Dr. B. A. Gould for measurements of the Cordova photographs 500.00

1886. Oct. 7, to Prof. E. C. Pickering for work on stellar photography $1,000.00

1887. Jan. 30, to Dr. B. A. Gould for measurements of the Cordova photographs 500.00

1887. Mar. 22, to Prof. A. A. Michelson for researches on light..... 500.00
The results of this work have been published in the American Journal of Science and Arts for May, 1886.

1887. Mar. 24, to Prof. H. A. Rowland for continuation of work on solar spectrum 1,000.00
Professor Rowland's results have not been published in full. They are partly contained in the American Journal of Science for March, 1887, and are embodied in Professor Rowland's magnificent photographic map of the solar spectrum, second series, 1888. Nine plates, 12 by 36 inches.

1887. June 2, to Prof. S. Newcomb for the Eclipse Expediton to Japan.... 2,000.00
The full report of the expedition, by Prof. D. P. Todd, was presented to the Academy, April 19, 1889.

1887. July 26, to Prof. A. A. Michelson for researches on light..... 500.00

1887. Nov. 15, to Prof. Wolcott Gibbs for a systematic study of the action of chemical compounds upon the animal system..... 1,000.00

1888. Apr. 25, to Prof. T. C. Mendenhall, to carry on seismological researches. 100.00

1888. June 10, to Prof. E. D. Cope for the purpose of conducting researches on the extinct vertebrata of North America; for the payment of the salary of one expert préparateur of the fossils in extracting them from the rock, cementing fragments, etc..... 600.00

1888. Sept. 15, to Prof. E. D. Cope (appropriation No. 2) for the payment of expenses involved in work on vertebrate palæontology..... 600.00

1888. Nov. 2, to Prof. D. P. Todd, to defray the expenses of printing and distributing instructions with reference to observations to be made by volunteers on the total eclipse of January 1, 1889 ..... 125.00
The results are embodied in part in a paper *On composite coronagraphy*, read before the Academy, April 17, 1889.

1888. Dec. 7, to Prof. Wolcott Gibbs (second appropriation) for a systematic study of the action of chemical compounds upon the animal system. 1,000.00

As already stated, it is believed that this report is complete, as the treasurer's books were not stolen together with the applications and vouchers. As it is very desirable, however, that the report should be made as complete as possible, the undersigned would suggest that it should be printed before final acceptance by the Academy, and that printed copies should be distributed among members who have received appropriations from the fund, with the view of obtaining any correction necessary.

Respectfully submitted.

JAMES D. DANA.
WOLCOTT GIBBS.
J. E. HILGARD.

THE JOSEPH HENRY FUND.

At the April meeting, 1878, the treasurer of the Academy made a statement respecting the "Joseph Henry Fund" of $40,000, contributed by Fairman Rogers, Joseph Patterson, George W. Childs, A. J. Drexel, F. A. Drexel, Charles H. Rogers, J. G. Fell, Isaac Lea, Asa Packer, John Welsh, W. Blanchard, James Lennox, executors of the estate of John C. Green, Mrs. John C. Green, Robert L. Stuart, Miss

C. L. Wolfe, William Libbey, E. N. Dickerson, Cyrus W. Field, Thomas A. Scott, W. W. Corcoran, George P. Wetmore, Thomas H. Powers, J. S. Morgan, J. Pierrepont Morgan, I. V. Williamson, John W. Garrett, Charles S. Coxe, Cyrus H. McCormick, J. E. Caldwell, William Weightman, Alexander Brown, Henry C. Gibson, J. Donald Cameron, Samuel M. Felton, H. H. Houston, and Nat. Thayer, "as an expression of the donors' respect and esteem for Professor Henry's personal virtues, their sense of his life's great devotion to science, with its results of important discoveries, and of his constant labors to increase and diffuse knowledge and promote the welfare of mankind," which sum of $40,000 they have caused to be invested in certain securities, and to be deposited with and held by the Pennsylvania Company for insurance of lives and granting annuities in trust, from time to time to collect the income thereon, and to pay over the same to Prof. Joseph Henry during his natural life, and after his death to his wife and daughters, and after the death of the last survivor "to deliver the said fund and the securities in which it shall then be invested to the National Academy of Sciences, to be thenceforward.forever held in trust under the name and title of the 'Joseph Henry Fund,' the principal to be forever held intact, and the income to be from time to time applied by the said National Academy of Sciences, in its sole discretion, to assist meritorious investigators, especially in the direction of original research."

A resolution was adopted accepting said trust, and directing, authorizing, and empowering Fairman Rogers, treasurer of the Academy, in its name and upon its behalf, to affix its corporate seal to and to execute all such deeds, writings, and assurances in law as may be necessary to carry the said trust into effect.

On motion of Mr. W. B. Rogers it was unanimously—

Resolved, That the National Academy of Sciences hereby present their grateful acknowledgments to Messrs. Joseph Patterson, Fairman Rogers, George W. Childs, and the other subscribers to the "Joseph Henry Fund," for the generous contributions by which they have expressed their appreciation of the lifelong and disinterested scientific labors of the revered president of the Academy, and have provided an important future addition to its means of scientific usefulness.

THE WATSON TRUST FUND.

This trust fund was left to the Academy by one of its most distinguished members, Prof. James C. Watson, at his death in 1880. An extract from the will and the action of the Academy in reference to it are given below, and also the awards since made by the Academy from this fund.

EXTRACT FROM THE WILL OF JAMES C. WATSON.

The will of the late James C. Watson contains, with bequests to several members of his family, the following provisions:

Fifth. I give and devise, subject to conditions and legacies hereinbefore and hereafter mentioned, all the rest, residue, and remainder of my real and personal estate to the National Academy of Sciences of the United States of America, of which I am a member, which said Academy was incorporated by act of Congress approved March

3, A. D. 1863, to be aggregated, kept, and invested as a perpetual fund, the income of which shall be expended by said Academy for the promotion of astronomical science.

I direct that all the stocks, bonds, and securities owned by me (than those specifically bequeathed otherwise) be converted into money on the most advantageous terms possible, and as soon as it may be advantageous to do so, and paid over to the treasurer of said National Academy of Sciences. I direct that any other personal property belonging to me, as well as any real estate of which I may die possessed, except my books and scientific papers, be sold and disposed of as soon as may possibly be done advantageously to the interests of my estate, and that the proceeds thereof be paid over to the treasurer of said National Academy of Sciences.

I direct that my books and scientific papers be transferred to said National Academy of Sciences, to become part of the library of said Academy.

In order to carry out the wish hereinbefore expressed as to the disposal of the income from the fund resulting from my estate hereby devised to said National Academy of Sciences, I do hereby direct that the designation of the particular objects and work which may be aided by this fund shall be determined, subject to approval by a vote of the Academy, by a board of trustees, three in number, who shall be members of the Academy, and elected, after the first herein named, by said Academy whenever a vacancy may occur by death or otherwise. The trustees so appointed shall hold said office, unless voluntarily relinquished by them, during the period of their membership in said National Academy of Sciences; and I do hereby appoint and constitute Julius E. Hilgard, of the U. S. Coast Survey, and Simon Newcomb and J. H. C. Coffin, professors of mathematics, U. S. Navy, all of Washington, in the District of Columbia, to be the first board of trustees for the purposes herein named.

It is my wish that the Academy may, if it shall deem proper, provide for a gold medal of the value of $100, to be awarded, with a further gratuity of $100, from time to time, to the person in any country who shall make any astronomical discovery or produce any astronomical work worthy of reward and contributing to our science.

It is my further wish that provision be made for preparing and publishing tables of motion of small planets which have been discovered by me as soon as it may be practicable to do so, and I devise that in all cases the trustees and Academy shall act in harmony to obtain results of the greatest possible aid to our science from the income fund resulting from my estate. I desire that results so obtained shall be published as speedily as possible, in such manner as may be provided by the Academy.

I direct that the said National Academy of Sciences take all necessary and proper measures to invest the fund resulting from the property hereby devised where they may be safe and yield the greatest possible income consistent with safety.

This will is dated July 11, 1874.

STATEMENT IN REGARD TO THE BEQUEST OF THE LATE PROFESSOR WATSON, BY MR. NEWCOMB, CHAIRMAN OF THE TRUSTEES.

April, 1881.

It is known to members of the Academy that our late lamented colleague, Prof. James C. Watson, has bequeathed all his estate, after satisfying certain claims and paying certain annuities to relatives, to the National Academy of Sciences, in trust for the promotion of astronomical researches. Having been named one of the executors, I took occasion during a journey to Madison last January to inform myself of the condition of the estate, and the probable benefits to be derived from it. I find that, although almost the entire property was in the State of Michigan, yet, as he was a resident of Wisconsin at the time of his death, and as his estate was entirely personal, the courts of the latter had exclusive jurisdiction of the bequest.

As none of the executors named in the will are residents in Wisconsin, and as they are widely scattered, it will be difficult for more than one to act, and the administration will have to be conducted under the direction of the probate court at Madison.

It is difficult to see what amount, if any, the Academy will ultimately receive for the purposes desired by the testator, owing to two causes, the unsettled condition of several business enterprises in which our colleague had invested much of his means, and the indefinite character of his business arrangements with the University of Wisconsin. The only item of the estate to which even approximate cash value *can* be assigned consists of stock and policy in the Mutual Life Insurance Company of Michigan, the total value of which probably amounts to about $30,000.

The next item in importance is the Printing and Publishing Company of Ann Arbor, of which the deceased owned 499 shares out of the total of 500. The actual cost of this stock was about $26,000, but the property at present owned by the company is of so miscellaneous a character and it is so complicated by litigation as to make it hardly possible even to guess at the value of its assets.

I judge, however, from a general examination of its property, that should the company go into liquidation it might realize anywhere from $5,000 to $15,000, but a debt of $5,000 is due from it, so that the net amount may range from zero to $10,000, the lower ultimate being more probable than the upper one.

The next item in importance is the Chase Publishing Company of Toledo, which is said to be profitable, but to it no definite value can be assigned.

On the other hand, our colleague at Madison expended considerable sums on improvements of the observatory and its grounds, without any distinct understanding with the board of regents as to who should ultimately bear the expense. These improvements include the Watson solar observatory, the students' observatory, the fitting up of the director's house, the purchase of the transit instrument, and several other items. An amount of between $5,000 and $10,000 is, I believe, due on these various improvements, so that if the estate is to pay for them all it will be materially diminished.

I may also add that, under the laws of Wisconsin, Mrs. Watson is entitled in lieu of the provision made for her in the will to accept one-third of the net proceeds of the estate. It has been suggested that in the event of the estate not realizing the amount expected an arrangement should be made with Mrs. Watson to allow her the entire income from it during her life on condition of the entire amount reverting to the Academy on her death. This arrangement will probably commend itself if the amount shall be found insufficient to carry out the objects which our lamented colleague had at heart in making the bequest.

The matter of the action of the Academy on the Watson bequest was referred to the council.

STATEMENTS RELATING TO THE WATSON FUND.

The final account of Leopold Gruner, the only executor named in the will, was rendered to the county court of ——— County, in the State of Wisconsin, May 31, 1882.

Mrs. Annette H. Watson claimed, and was allowed under the laws of Wisconsin, one-third of the estate of her late husband in lieu of the bequests made her.

The decree of the court, made July 5, 1882, adjudges that the said executor retain in his hands the sum of $3,000 for the purpose of paying the annuity bequeathed by the said James C. Watson, deceased, to his mother, Rebecca E. Watson.

That all the rest, residue, and remainder of said personal estate, consisting of the sum of $5,057.25 in cash, 174 shares of said stock of the Michigan Mutual Life Insurance Company, and the undivided two-thirds of said miscellaneous books, and all

and singular the said books and scientific papers as delivered by said executor to it, be, and the same are hereby, assigned and set over to the said National Academy of Sciences, its successors and assignees.

Under this decree, the Academy received from the executor $7,057.25 in cash and 134 shares of stock of the Michigan Mutual Life Insurance Company, of the par value of $6,700, the reduction of 40 shares of the Michigan Mutual Life Insurance Company and the increase of $2,000 having been made at the request of Mrs. Watson.

At the April meeting, 1883, the treasurer of the Academy, Mr. Coffin, presented the following resolutions in regard to the bequests of the late James C. Watson, which were adopted:

Resolved, That the National Academy of Sciences accepts the bequests of the late James C. Watson for the trust and purpose expressed in his will.

Resolved, That the Academy approves of the appropriation make by the board of trustees of $500, or as much of the same as may be necessary, to aid in the observation of the total solar eclipse on May 6, 1883.

In April, 1884, the following recommendations of the trustees of the Watson fund, upon the advice of the council, were adopted by the Academy (these recommendations are based on the present cash balance of $1,292.75, and the annual income of present investments, $748):

(1) That the invested fund be increased by the addition of $850.25, so that its par value may equal, as near as may be, $13,750.25, the sum received from Professor Watson's estate.

(2) That dies, with suitable designs, be prepared for a medal to be awarded from time to time to the person in any country who shall make any astronomical discovery or produce any astronomical work worthy of special reward and contributing to the progress of astronomy, in compliance with the expressed wishes of Professor Watson.

(3) That there be set aside annually the sum of $500, or as much thereof as may be necessary and available, to commence work on tables of the small planets discovered by Professor Watson, as also expressly desired by him in his bequest to the Academy, such work to be under the direction of Mr. Newcomb.

At the stated meeting of the Academy, held in Washington, in April, 1885, Mr. Coffin, on the part of the board of trustees of the Watson fund, reported that, since the session of the Academy in April, 1884, in accordance with resolutions then passed, the invested fund had been increased to $13,750, the sum received from the bequest of Professor Watson, and progress had been made in procuring a model of the proposed Watson medal, and the work on the small planets, under the direction of Mr. Newcomb, had been commenced, but no money had yet been drawn from the treasury for that purpose.

At the April session, 1886, Mr. Newcomb, at the request of the board of trustees of the Watson fund, presented the following resolution, which was adopted by the Academy:

Resolved, That the Watson medal and the further sum of $100 in gold be awarded to Dr. Benjamin Apthorp Gould, for his valuable labors for nearly 40 years in promoting the progress in astronomical science, and especially for his successful establishment of the National Observatory of the Argentine Republic, as manifested in the six volumes of observations recently prepared and published by him.

By vote of the Academy, the trustees of the Watson fund were authorized to take the proper steps for having the medal struck.

Mr. Newcomb reported that, while appropriations of money had been made for carrying out that part of Professor Watson's will which provided for the making of tables of the asteroids, work had been only partially commenced, owing to the difficulty of finding a sufficiently skilled computer to make such computations. They had been obliged to send abroad to find a person to make the computations necessary to enable an unskilled computer to continue the work on the other planets.

During the Washington meeting of the Academy, April, 1887, the president stated that Mr. Hilgard had resigned his position on the board of trustees of the Watson fund, and that Mr. B. A. Gould had been appointed to fill the vacancy.

PRESENTATION OF THE FIRST WATSON MEDAL.

At a public session of the Academy, held on the evening of April 20, 1887, the first James Watson medal and the sum of $100 in gold were presented to Dr. B. A. Gould for his valuable labors for nearly 40 years in promoting the progress of astronomical science.

The president of the Academy, Professor Marsh, in his address in making this presentation, gave an account of the great work accomplished by Dr. Gould. The following extracts from this address will place on record here the main reasons for the first award of the Watson medal:

EXTRACTS FROM THE PRESIDENT'S ADDRESS.

The name of Benjamin Apthorp Gould, whom we are thus to honor to-night, is so familiar by his recent works, that we are in danger of forgetting his services as the pioneer in introducing the methods, culture, and ideas of German astronomy into this country. The years 1840 to 1843 might almost be considered as those of the birth of American astronomy. Then were founded the Washington and Cambridge Observatories, which brought forth such men as Walker, Hubbard, and Bond. Dr. Gould was then a student at Harvard, imbibing from Professor Pierce that enthusiasm for scientific work which that teacher so well knew how to inspire. Soon after graduation, Mr. Gould sailed for Europe to pursue under Bessel, Gauss, and others, the study of his favorite science in its most advanced phases. Winning the degree of PH. D. at Göttingen, he returned home full of student's honors, and started the Astronomical Journal. Later, he was appointed by Bache as head of the longitude department of the Coast Survey, in which position it

was a part of his duty to perfect and apply the method of determining longitudes by telegraph.

The Astronomical Journal was largely a labor of love, as the income could not possibly balance the outlay. Discontinued in 1861 on account of the advent of the civil war, it has recently been reëstablished after a silence of just 25 years. In 1868, Dr. Gould resigned his position on the Coast Survey, and shortly afterward accepted an invitation from the Argentine Government to found a national observatory in that country.

Sailing for his new post of duty in 1870, he expatriated himself for a period of 15 years. It is more especially for his work during this period that the distinction which we celebrate to-night was conferred upon him.

The northern hemisphere being the seat of civilization and the home of the astronomers of the world, the natural result was that the phenomena of the southern heavens were much less studied than those of the northern. Ardent astronomers were from time to time attracted thither to reap the harvest which nature had sown, as Lacaille in 1750, and Herschel in 1830, but such men could simply do little in a field so great. Permanent observatories were from time to time established. First, that at the Cape of Good Hope, by the British Government; then, that of the Chilian National Observatory, at Santiago, by our late honored associate, James M. Gilliss; and yet more recently, the Melbourne Observatory, by the government of South Australia. But these institutions were not prepared to make that complete survey of the southern heavens which our associate had planned.

Dr. Gould's great works are:

(1) The Uranometria Argentina, one volume, with large atlas. This work comprises a catalogue and map of all the stars down to the seventh magnitude, from the south pole to 10 degrees north declination, the position and magnitude of each being given. It is not a mere catalogue, but embodies an exhaustive study of the distribution of stars of different magnitudes and their relations to the Milky Way.

(2) The Argentine General Catalogue, one volume, 4to, contains the places of nearly 33,000 (32,448) stars, determined with the highest accuracy with the meridian circle. Three determinations of each star were generally made. The catalogue is followed by a list of the stars contained in some of the most noted clusters.

(3) The Cordoba Zone Catalogues, seven volumes, give the places of 73,160 stars down to the tenth magnitude.

The mere statement of these numbers affords no conception of the labor involved in these works. We may fairly compare the general catalogue with the zone observations projected by the International Astronomical Society more than twenty years ago. As far back as 1863, the work of determining the position of all the stars north of the equator down to the ninth magnitude was divided up among such observatories of Europe and America as were prepared to participate in it.

Their work is still incomplete, while that of our associate, commenced long afterwards, lies finished before us.

Many variable stars were discovered during these investigations, and two whose proper motion is about 6″ annually are equaled by only one other, so far as is known.

Eleven hundred photographs of southern star clusters taken during the years 1872–1883 have been preserved, and are now undergoing measurement.

Five volumes of meteorological observations have been published from stations established in all parts of the Argentine territory, giving the climate relations of the southern half of the continent, and establishing the isothermal lines.

The observatory and a national meteorological office were left in full organization and activity.

This vast and comprehensive work is embraced in 13 quarto volumes already published, and 6 are now prepared for publication, making 19 in all.

PRESENTATION OF SECOND WATSON MEDAL.

In 1888, at the April meeting of the Academy, the board of trustees of the Watson fund recommended that the second Watson medal be given to Prof. Edward Schönfeld, director of the University of Bonn, Germany, for his services in cataloguing and mapping the stars visible in our latitudes, and especially for his recently published southern *Durchmusterung*. This recommendation was approved by the Academy.

The following report was presented to the Academy by the board of trustees, giving the reasons for the award of the Watson medal to Professor Schönfeld:

REPORT OF THE TRUSTEES UPON THE AWARD OF THE WATSON MEDAL.

To the National Academy of Sciences:

The Board of Trustees of the Watson fund recommend that the Watson medal, with $100 in gold, according to the provisions of the trust, be awarded by the Academy to Prof. Edward Schönfeld, Director of the University Observatory at Bonn, for his services in cataloguing and mapping the stars visible in our latitudes, and especially for his recently published southern *Durchmusterung*.

The plan of forming a catalogue of all the stars brighter than the tenth magnitude, from the north pole to the equator, was conceived many years since by our late honored associate, the illustrious Argelander. The actual work was begun in the spring of 1852, but was so severe that, after a year, Argelander was obliged to restrict his personal share in it to labors of revision and verification, leaving the actual telescopic survey to others, chief among whom were his assistants and

pupils, Dr. Schönfeld, now his successor in the Observatory, and Dr. Krüger, now Director of the Observatory at Kiel.

This magnificent undertaking was thoroughly accomplished, and the results, under the title of *Durchmusterung des nördlichen Himmels*, were published in three quarto volumes, the last of which appeared in 1862. This classic work has been since then, and must long remain, one of the most indispensable books of reference for the practical astronomer. It derives, if possible, an additional importance from serving as the basis for the vast undertaking of accurately determining the positions of all stars north of the equator to the ninth magnitude inclusive. This has been going forward for about twenty years, by the coöperation of a number of the principal observatories of the world, under the guidance of the *Astronomische Gesellschaft*, an international organization, in the establishment and conduct of which, Professor Schönfeld has taken a conspicuous part.

Meanwhile, his researches concerning the variable stars, both his many discoveries, and his thorough study of the laws which govern their variation, have not merely placed Professor Schönfeld in the foremost rank of the investigators in this department of astronomy, but, in the universal opinion of astronomers, at the head of all busy laborers in this field. To him, questions of doubtful nomenclature or notation have been submitted by astronomers of whatever nationality, and his verdict always commands universal acceptance. In this, as in the other fields of stellar astronomy already mentioned, the mantle of his great predecessor, Argelander, has fallen upon worthy shoulders, and the Observatory of Bonn has maintained its peculiar and unsurpassed eminence.

But the greatest achievement of Professor Schönfeld, and that which has especially prompted the trustees of the Watson fund in their recommendation of this award, is his last published work, the extension of the *Durchmusterung* from the equator to the southern tropic. Not only has he accomplished this in full conformity with the previous survey of the northern sky, in which he took so important a part, but he has emulated the example of his predecessor and teacher by the improvement of previous methods. The experience which he has attained in the northern *Durchmusterung* enabled him to extend the limit of brightness up to which his catalogue is exhaustive, and the 23 degrees of southern declination which it includes have been explored and surveyed by himself alone; he having made all the observations personally, and having personally computed them, and personally edited and superintended their publication. This southern extension of the census of the sky contains —— stars, the positions of all of which have been reduced to the epoch of Argelander's *Durchmusterung*, and which are all likewise represented upon charts constructed with all attainable accuracy.

So brilliant and priceless a contribution to our stellar knowledge would demand recognition, even had it not been preceded by the other important and conspicuous labors to which we have referred.

The board of trustees has consequently felt no hesitation in its unanimous recommendation to the Academy.

SIMON NEWCOMB.
J. H. C. COFFIN.
B. A. GOULD.

WASHINGTON, *April* 18, 1888.

At a public session of the Academy, held on the evening of April 17, 1889, the second James Watson gold medal and the sum of $100 in gold were presented to Prof. Edward Schönfeld, Director of the Observatory of Bonn, Germany.

As Professor Schönfeld was not present at this meeting, the foreign secretary was instructed to forward the medal and $100 in gold to him through the German embassy. This was done, and the medal and fund were duly received by Dr. Schönfeld, who has since acknowledged their receipt and expressed to the Academy his high appreciation of the honor thus conferred upon him.

THE HENRY DRAPER FUND.

At the April session in 1883, the president announced that Mrs. Henry Draper, widow of Dr. Henry Draper, late an honored member of the Academy, had presented to the National Academy of Sciences a fund of $6,000 for the establishment of a gold medal to be awarded every two years to the individual in this or any country who makes the most important discovery in astronomical physics, the value of said medal to be $200, and the fund, in case the medal should not be awarded, to be applied by the Academy to investigations in the same department of science.

The text of the deed of gift is as follows:

DEED OF TRUST OF MRS. HENRY DRAPER.

Know all men by these presents that I, Mary Anna Palmer Draper, of the city, county, and State of New York, in consideration of the premises, and of the acceptance of the within trust by the National Academy of Sciences, and also in consideration of divers other good and valuable considerations, I, the said Mary Anna Palmer Draper, hereto moving, have given, granted, assigned, transferred, and set over, and by these presents do give, grant, assign, transfer, and set over unto the said National Academy of Sciences, and to their successors forever, a certain fund or sum of $6,000, with the interest and income thereof, to have and to hold the same in trust, nevertheless upon the special trusts, and for the uses and purposes following, to wit:

First. In trust to invest, and to reinvest, the said sum of $6,000, and to keep the same invested in good and safe securities, or in such other manner as shall be, in their opinion, best for the preservation and maintenance of said fund.

Second. In trust to use the interest and income thereof for the purpose of striking a gold medal, which shall be called the "Henry Draper Medal," shall be of the value

of $200, and shall be struck in a die to be selected and presented to said National Academy of Sciences, by me, the said Mary Anna Palmer Draper. And the said medal shall be awarded and presented from time to time by the said National Academy of Sciences to any person in the United States of America or elsewhere, who shall make an original investigation in astronomical physics, the results of which shall be made known to the public, such results being, in the opinion of the said National Academy of Sciences, of sufficient importance and benefit to science to merit such recognition; provided, however, that said medal shall not be presented or awarded more frequently than once in 2 years, and provided, also, that the investigation for which it is awarded, or the completed publication thereof, shall have been made since the time of the last preceding award and presentation of said medal.

Third. In trust that if discoveries of equal importance shall be made in astronomical physics at or about the same time in the United States of America, and also in some other part of the world, each of which discoveries might, in the opinion of the said Academy, entitle the discoverer to be considered as a competitor for said medal, preference shall be given in the awarding thereof to discoveries made by a citizen of the said United States of America.

Fourth. In trust that if the said die shall at any time be lost, destroyed, broken, or in any way rendered unfit for the purpose of striking the said medal, a new die shall be procured, exactly similar to the one selected and presented as aforesaid, and shall be paid for out of the interest and income of the said fund; and such sum or sums of money as shall at any time or times be necessary for the proper care, custody, and protection of the said die or of the said fund hereby given, shall also be taken from and out of the interest and income of the said fund, whenever the same shall be deemed necessary by the said National Academy of Sciences.

Fifth. In trust that if at any time or times the interest and income of the said trust fund of $6,000 shall exceed the amount necessary for the striking of said medal and the care of the said die, and of the fund, such surplus over and above the sum or sums so required for the purposes of the trust as hereinbefore recited and set forth shall be used in such manner as shall be selected by said National Academy of Sciences, in aid of investigation and work in astronomical physics to be made and carried on by a citizen or citizens of the United States of America.

And the said National Academy of Sciences doth signify its acceptance of the said fund of $6,000, and doth engage to hold and manage the same upon the trusts and for the uses and purposes herein mentioned and set forth.

In witness whereof I, the said Mary Anna Palmer Draper, have hereunto set my hand and seal, and the said National Academy of Sciences hath hereunto caused its corporate seal to be subscribed by its president, this thirteenth day of April, in the year one thousand eight hundred and eighty-three.

[SEAL.] MARY ANNA PALMER DRAPER.

Sealed and delivered in the presence of—
EDWARD A. DIXON.
MORNAY WILLIAMS.
As to Mary Anna Palmer Draper.

O. C. MARSH,
President of the National Academy of Sciences.

Witnesses to the signature of O. C. Marsh—
J. H. C. COFFIN.
ASAPH HALL.
SAM'L H. WALKER.

Executed and acknowledged before Mornay Williams, notary public, New York County.

Acknowledgment of officer of the Academy before Samuel H. Walker, notary public, District of Columbia.

It was moved and adopted that the deed of Mrs. Henry Draper be entered at length in the minutes of the meeting.

The following resolution was recommended by the council and adopted:

Resolved, That a permanent committee of five be appointed to consider the subject of the bestowal of the Henry Draper medal, and to recommend to the Academy, from time to time, such persons as they may consider deserving of the medal, with the ground of their recommendation.

In accordance with this resolution the president appointed the following members as the committee on the Henry Draper medal:

G. F. Barker, *Chairman*,
W. Gibbs. A. W. Wright.
S. Newcomb. C. A. Young.

The following resolution relative to the fund presented by Mrs. Henry Draper was reported and adopted:

Resolved, That the National Academy of Sciences accepts the fund of six thousand dollars presented to it by Mrs. Mary Anna Palmer Draper, and engages to maintain the same upon the trusts for the uses and purposes mentioned and set forth in a certain deed executed by her on the 13th day of April, in the year of our Lord one thousand eight hundred and eighty-three, and signifies such acceptance by causing the corporate seal of the Academy to be affixed and the said deed to be signed by its president.

The president appointed the following committee to consider the form of a resolution of thanks to Mrs. Draper: Messrs. W. Gibbs and G. F. Barker.

In 1884, at the April meeting, it was resolved, on recommendation of the council, that the home secretary have engrossed and properly signed the resolution of thanks to Mrs. Draper drawn up at the stated session of the Academy in 1883, as follows:

Resolved, That the grateful acknowledgments of the National Academy of Sciences are due to Mrs. Draper for the confidence which she has shown in selecting the Academy as the trustee of a fund designed to reward scientific labor, and by so doing to commemorate the services of one who was loved for his virtues, and honored for his eminent success in the branch of science to which he devoted his noble and useful life.

PRESENTATION OF FIRST DRAPER MEDAL.

At the stated session of the Academy in 1885, the committee on the Henry Draper medal reported that it had had before it the claims of various investigators working in the field of astronomical physics, and had considered fully their claims to the distinction implied in the award of this medal by the Academy.

That, as a result of its investigations, the committee recommended to the Academy the award of the first Henry Draper medal to our fellow-member, Prof. S. P. Langley, for his researches and discoveries in relation to solar radiation. This recommendation was adopted.

The following is the report of the committee:

REPORT OF THE COMMITTEE.

To the National Academy of Sciences:

By a resolution of the Academy, adopted April 19, 1883, it is made the duty of the committee on the Henry Draper medal "to recommend to the Academy, from time to time, such persons as they may consider deserving of the medal, with the ground of their recommendation."

The original deed of trust provides that "the said medal shall be awarded from time to time by the said National Academy of Sciences to any person in the United States of America or elsewhere, who shall make an original investigation in astronomical physics, the results of which shall be made known to the public, such results being, in the opinion of the said National Academy of Sciences, of sufficient importance and benefit to science to merit such recognition."

In accordance with the above resolution of the Academy, and with the provisions of the deed of trust, the committee on the Henry Draper medal begs leave to report that it has taken into consideration the researches which have recently been made by the men of science of this and other countries in the department of astronomical physics, and that in consequence of such examination the committee unanimously recommends that the Academy award the Henry Draper gold medal to Prof. Samuel P. Langley, of Allegheny, Pennsylvania. The committee bases this recommendation upon the numerous investigations of a high order of merit which have been made by Professor Langley within the past few years in solar physics, and especially in the domain of radiant energy. In corroboration of its opinion, the committee desires to specify the following memoirs, in which the results of these investigations are, for the most part, embodied:

1. *On the Minute Structure of the Solar Photosphere.* (Am. J. Sci., III, vii, 87, February, 1874.)

This paper gives the result of two years' work, and announces the discovery (since confirmed by Janssen) that four-fifths of the sun's light comes from less than one-fifth of its surface. It was illustrated with a plate containing the most detailed representation of a sun spot, which had appeared up to that time.

2. *The External Aspects of the Sun.* (J. Frank. Inst., August and September, 1874.)

In this paper, the noted engraving of the "typical sun spot" appeared for the first time. It was executed for the purpose of giving material for passing judgment on the current theories of sun spots, and had undoubtedly a considerable influence in determining the present conviction of students of solar physics that the surface of the sun is essentially gaseous or cloudlike. This engraving has been reproduced by Secchi, Proctor, Young, and nearly every author who has written on the subject.

3. *On the Comparison of Certain Theories of Solar Structure with Observation.* (Am. J. Sci., III, ix, 192, March, 1875. Published simultaneously in Memorie degli Spettroscopisti Italiani, Vol. IV.)

A statement of the above consequences more in detail.

4. *Sur la température relative des diverses régions du soleil.* Première Partie. Les noyaux noirs des taches; Deuxième Partie. Région équatoriale et régions polaires. (Comptes Rendus, March 22 and 29, 1875.)

5. *Étude des radiations superficielles du soleil.* (Comptes Rendus, September 8, 1875.)

The author shows in these papers the existence of a remarkable thermochroic action in the solar atmosphere, such that the vibrations of great wave-length are less absorbed than the visible and ultra-violet. He proves also that no such difference between the polar and equatorial radiation as has been asserted by Secchi exists. Hence, it follows that the sun, if deprived of his atmosphere, would appear *blue*. This statement, however, was first made in explicit terms at the Detroit meeting of the American Association for the Advancement of Science.

See the paper entitled—

6. *The Solar Atmosphere.* (Am. J. Sci., III, x, 490, December, 1875. Suppl. No.)

7. *Measurement of the direct effect of Sun spots on Terrestrial Climates.* (Monthly Not. Royal Astr. Soc., November, 1876.)

Here the author essays a new method of determining whether sun spots affect terrestrial climates or not, although he does not undertake to say whether they may not be the indices of some other action which does affect them. Considering the spots merely as interruptions of a determinate quantity of the solar heat, he succeeds in demonstrating that their total effect (from this point of view) on terrestrial climates can not alter the mean temperature of the earth by so much as one degree Fahrenheit.

8. *On certain Remarkable Groups in the Lower Spectrum.* (Proc. Am. Acad., 1878.)

Contains the author's discovery of the duplicity of the rays in the "great A" group of the solar spectrum.

9. *On the Temperature of the Sun.* (Proc. Am. Acad., 1878.)

In this paper, the author publishes the results of his comparison of the heat and light of the sun with that of the molten steel in the Bessemer converter. At this time (so late as 1878) the temperature of the sun was maintained by physicists of high repute to be not over 1500° C. The author's object in this comparison was not to determine this temperature, but to furnish irrefragable proof that it was at any rate very much higher than that which physicists, misled by Dulong and Petit's law, had assigned to it. Incidentally, the conclusion was reached that this celebrated law itself is absolutely unreliable, a position which is now fully conceded.

10. *Observations on Mount Etna.* (Am. J. Sci. III, xx, 33, July, 1880.)

The author here gives the results of his studies made during the winter of 1878–'79, upon the upper slopes of Mount Etna, which were *connected* with the improvement of solar observation by the employment of a station at a high altitude.

11. *The Progress of Solar Physics.*

An address as president of the physical section of the American Association for the Advancement of Science, delivered at Saratoga in August, 1879. (Proc. Am. Assoc., xxviii, 51, 1879.)

12. *The Bolometer and Radiant Energy.* (Proc. Am. Acad., xvi, 1880.)

13. *The Bolometer.* (Proc. Am. Metrol. Soc., December, 1880.)

14. *The Actinic Balance.* (Am. J. Sci., III, xxi, 187, March, 1881.)

His solar studies having convinced him that two-thirds of the sun's radiant energy was unexplored for want of the proper apparatus, the author spent the year 1880 in experiments on the construction of an instrument for analyzing and measuring this and like forms of energy. This instrument which he called the bolometer, from *Βολη* and *μετρον*, is described in the papers above mentioned.

15. *Sur la distribution de l'energie dans le spectre solaire normal.* (Comptes Rendus, March 21, 1881.)

16. *Distribution de l'energie dans le spectre normal.* (Comptes Rendus, July 18, 1881.)

17. *La distribution de l'energie dans le spectre normal.* (Ann. Chim. Phys., February, 1882.)

The first fruit of the use of this new instrument was the demonstration that the amount of heat which the earth receives from the sun (the solar constant) had been greatly underestimated, owing, among other causes, to inability previously to measure the solar heat in sufficiently small portions of the spectrum. The leading facts in regard to the distribution of energy in the normal spectrum, from the sun, and the distribution of this solar energy before absorption by the earth's atmosphere, are given in these papers.

18. *The Selective Absorption of Solar Energy.* (Am. J. Sci., III, xxv, 169, March, 1883. Also, Ann. Phys. Chem., xix, 1883, and Ann. Chim. Phys., V, xxix, 497, August, 1883.)

Treated more fully in "The Professional Papers of the Signal Service. No. xv. Researches on Solar Heat and its Absorption by the Earth's Atmosphere. Expedition to Mount Whitney, 1884."

The results already announced were so important in their bearing on the science of terrestial meteorology that the author conducted, under the joint auspices of the Allegheny Observatory and the United States Signal Service, an expedition to the Sierra Nevadas of Southern California, the results of which were published extensively in American and foreign scientific journals. In the first article above mentioned is an account of the leading facts observed; which are that the sun's light is essentially *blue*, and that what we call "white" light is due to the absorption of these blue rays, first by the sun's atmosphere and then by our own. It had always been supposed that the sun's red and infra-red rays were powerfully absorbed by our own atmosphere, which acted, according to the familiar comparison of Poisson and Pouillet, like the glass cover of a hot-bed, which absorbs solar heat more and more as we approach the infra-red. This universally accepted belief was directly contradicted by these researches, and it was shown that the nature as well as the

amount of the absorption of the solar rays had been so wholly misunderstood that the general outlines of these important truths were here given for the first time. The value of the solar constant, which until now had been accepted, was radically altered, Pouillet's value, 1.7 calories, being raised to 3. In connection with this, a map was given of the infra-red solar spectrum, containing numerous lines and bands hitherto unknown; and, what was wholly new, with their places fixed upon the normal or wave-length scale by direct observation.

19. *Memoir on the Experimental Determination of Wave-lengths in the Invisible Prismatic Spectrum.* (Mem. Nat. Acad. Sci., 1884 (Read October, 1883). Also Am. J. Sci., III, xxvii, 169, March, 1884, and Ann. Phys. Chem., July, 1884.)

Almost, if not absolutely, all of our present knowledge of the constitution of bodies forming the external universe is dependent upon our information concerning the wave-lengths of the energy they send us, of which that coming in the form of light and which is visible is but the smaller portion. Inasmuch as until lately we have known almost nothing about any waves but visible ones, all our knowledge about terrestrial and other dark-heat radiation is in a condition of empiricism even to-day; a fact which is a great reproach to physical science. This arises chiefly from our want of knowledge in the past of any means of determining what these wave-lengths are, or, as a consequence of this, from our inability to analyze the invisible spectrum (in which two-third of the solar energy resides) in the way we can analyze the visible. The memoir above mentioned fixes the wave-lengths of solar heat, which had been known hitherto in the visible spectrum only, throughout its whole extent, and for the first time gives a trustworthy means of investigating that unknown major portion of the whole solar energy on which all organic life depends. This is the real purport of the somewhat abstruse, and, at first sight, unattractive investigations upon wave-lengths to which the author has devoted many years. He compares himself in this respect to one who is opening a path into hitherto unexplored country; not undertaking himself to study its natural history, but trying to execute the less attractive but indispensable labor of making the road on which future investigators may travel.

20. *On the Amount of the Atmospheric Absorption.* (Am. J. Sci., III, xxviii, 163, September, 1884.)

In this paper, it is shown, both from theoretical considerations and by experiment, that the absorption of the solar rays by the earth's atmosphere is at least double what it has commonly been supposed to be.

21. *On the Temperature of the Surface of the Moon.* (Mem. Nat. Acad. Sci., III, September, 1884.)

In this memoir, it is stated that it has been found possible to form a heat spectrum from the moon, and to analyze its different parts. The conclusion reached (which differs from that of Lord Rosse) is that the temperature of the sunlit surface of the moon can not be greatly above *zero centigrade.* Results of interest in connection with solar radiation *are also given.*

Professor Langley has published numerous other papers upon subjects connected with solar or astral physics, but it is believed that those which have now been mentioned will fully justify the recommendation of the committee.

GEORGE F. BARKER,
Chairman.
WOLCOTT GIBBS.
SIMON NEWCOMB.
ARTHUR W. WRIGHT.
CHARLES A. YOUNG.

WASHINGTON, *April* 24, 1885.

At a public session of the Academy, held on the evening of April 21, 1886, the first Henry Draper medal awarded by the Academy was presented to Prof. S. P. Langley by the president, who in a short address gave a résumé of Professor Langley's work in astronomical physics, and the reasons why the Academy had honored him with this medal.

On recommendation of the council, the Academy adopted the following resolution in April, 1885:

Resolved, That the treasurer be authorized to reserve from the income of the Draper fund, $65 each year, and such further sum as the committee on that fund may authorize, to be invested from time to time until the invested fund is increased to $6,000, the sum intrusted to the Academy by Mrs. Draper.

PRESENTATION OF SECOND DRAPER MEDAL.

Mr. Barker, chairman of the committee on the Henry Draper medal, reported, in April, 1887, that the committee recommended that the second Henry Draper medal be awarded to Prof. Edward C. Pickering, director of the Harvard Observatory, for his recent work in astronomical photometry and photography. This recommendation was adopted by the Academy.

The report of the committee for the award of this medal is as follows:

REPORT OF THE COMMITTEE.

To the National Academy of Sciences:

The committee on the Henry Draper medal begs leave herewith to report that it has carefully considered the investigations which have been made in astronomical physics since the award of this medal in 1885; and that, as a result of such consideration, the said committee desires to recommend that the Academy award this medal for the year 1887, to our fellow member, Prof. Edward C. Pickering, the director of the Harvard College Observatory, for his recent work in astronomical photometry and photography.

Professor Pickering was appointed to the position which he now holds in February, 1877. An examination of the annual reports which he has presented to the visiting committee of the observatory will show the

great amount and the great variety of the work which has been done there under his direction. Some of this work is purely astronomical; as an example of which, the excellent meridian circle work of Prof. William A. Rogers may be mentioned. But most of it is in the department of astronomical physics; and this it is to which the committee desires to direct attention.

The work in astronomical physics, which has been done in the observatory of Harvard College under Professor Pickering's immediate supervision, seems readily divisible into three classes: First, stellar photometry; second, stellar photography; and third, stellar spectrum photography.

I. The principal subdivisions of the photometric work are as follows:

(1) Observations of Jupiter's satellites at their disappearances in the shadow of the planet and their reappearances after the eclipse; with the object of determining the times at which these phenomena occur with greater accuracy than had hitherto been practicable.

(2) The determination of the relative brightness of all stars visible to the naked eye in the latitude of Cambridge.

(3) The determination of the relative brightness of several thousand stars of the first nine magnitudes, in order to fix the value of the arbitrary scales usually employed in estimating magnitudes.

(4) Comparisons of various objects at small apparent distances from each other, such as the components of double stars, different satellites of the same planet, etc.

(5) Numerous special investigations on proposed standards of magnitude, stars which have been used for comparison with variable stars, the light of nebulæ, etc.

All this photometric work has gone uninterruptedly forward with the aid of special photometers ingenuously devised for the purpose by Professor Pickering.

The observation of the eclipses of Jupiter's satellites has long been regarded as important, not only in determining the motions of the satellites themselves, but also in ascertaining the velocity of light. It is obvious that the observation of the disappearance or reappearance of a satellite is necessarily a photometric observation, and therefore that the subject is one to which improved means of photometric research are peculiarly applicable. But previous to Professor Pickering's undertaking, no one appears to have recognized the advantages resulting from the use of photometric apparatus in the observation of these eclipses. Recently, however, these advantages have been recognized in France, and researches similar in character to those of Professor Pickering have been undertaken there.

It is not expected that the observations of the eclipses made at the Harvard College Observatory will be fully reduced and published until they have been continued through a complete revolution of Jupiter (about 12 years). The first observation of this sort was made on the

23d of June, 1878. Up to the beginning of the present year, the total number of eclipses observed was 358, thirty-nine of which had occurred since October, 1885. The accuracy with which an eclipse of the first satellite can be observed appears, from the preliminary reductions, to be very satisfactory, the probable error seeming to be less than a second of time. The eclipses of the three outer satellites will furnish results nearly as useful, since the greater number of comparisons obtained during each eclipse compensates to a considerable extent for the comparative slowness of the changes in the brightness of the object observed.

The meridian photometer of Professor Pickering was first brought into use in the summer of 1879. The work of determining by the aid of this instrument the relative brightness of the stars which are visible to the naked eye was begun on the 25th of October of that year and was continued through 700 series of observations, 4,260 stars being included in the catalogue. The total number of comparisons made was 94,476, four comparisons constituting a complete observation. These results, together with an extended discussion of the estimated magnitudes obtained for the same stars by careful observers, as well as the results of previous photometric determinations of their relative brightness, were published in Volume XIV of the Annals of the Observatory.

The success of this photometer led Professor Pickering to have a larger instrument constructed, of the same kind, but which could be applied to the measurement of telescopic stars. The new photometer has given perfect satisfaction, and has enabled the brightness of stars to the ninth magnitude to be measured with a deviation from accuracy not exceeding a tenth of a magnitude. Moreover, stars can be measured with this instrument at the rate of forty stars an hour for an entire evening; and under favorable conditions, even one star a minute may be thus measured. During the year 1886, 209 series of measurements were made by Professor Pickering and his assistant, the total number of separate photometric comparisons being 59,800. In 1885,50,000 such comparisons were made, and in 1884, 27,500. A comparison of the Cambridge results with those obtained at Pulkowa shows that the average deviation of a measurement of the difference in brightness between two stars observed at both places does not exceed one-tenth of a magnitude. The principal work of the meridian photometer, the revision of the *Durchmusterung* magnitudes, is now approaching completion, nine-tenths of the observations having already been made.

It would seem to be manifest from the facts above enumerated, that practical stellar photometry has now been carried on for the first time by Professor Pickering to that extent and with that completeness which are requisite to give it general interest and importance.

II. The earliest investigations in stellar photography which were undertaken by Professor Pickering were begun in 1882, with the aid of a grant from the Rumford fund of the American Academy. They have

been continued subsequently by an appropriation made in June, 1885, from the Bache fund of the National Academy. The work which has been done in this direction has been summarized as follows:

"The present research was undertaken in 1882 with a lens having an aperture of only 2½ inches. It was shown that photography could be used as a means of forming charts of large portions of the sky, and of determining the light and color of stars in all portions of the heavens. Photographs of the trails of close polar stars no brighter than the eleventh magnitude were obtained without clockwork." "In 1885, the investigation was resumed with a telescope having an aperture of 8 inches. With this, one hundred and seventeen stars within one degree of the pole, one of them no brighter than the fourteenth magnitude, left trails. The average deviation of the measures of the brightness of these stars on different photographs was less than a tenth of a magnitude; a greater accordance than is given by any other photographic method. A similar result was obtained from the Pleiades, of which group over fifty left trails. Similar trails are now being obtained of the stars north of —30° in all right ascensions. This work began in the autumn of 1885, at 23^h, and has already been completed for more than half the sky. By photographing on the same plate polar stars near their upper and lower culminations, material has been accumulated for determining the atmospheric absorption each night of observation.

"A study has been made of the application of photography to the transit instrument. Measurements of the trails show that the time of a transit may be determined from its trail with an average deviation of 0.03 second, which is about half the corresponding deviation of eye observations.

"Charts may be constructed 5° square, having the same dimensions as those of Peters and Chacornac. A single exposure of one hour is required, and it is not necessary that the observer should remain with his eye at the telescope to correct the errors of the clock. Miscellaneous observations have been secured of the Pleiades, of the nebula in Orion, of Jupiter's satellites, and of various other objects."

III. Stellar spectrum photography, in which Professor Pickering has achieved his most marvelous results, was undertaken by him first in 1885, upon a plan entirely novel. Two important features of advantage were possessed by the new arrangement. The first consisted in placing the prism in front of the object glass; a plan already suggested by Fraunhofer, and tried for eye observations by Secchi. The second consisted in placing the refracting edge of the prism parallel to the motion of the star; *i. e.*, if the star was on the meridian, the refracting edge would be horizontal, and the spectrum north and south. The first device gives not only an enormous increase of light, but renders it possible for the stars over the entire field to impress their spectra upon the plate. Hence, while previous observers have been able to photograph but one star at a time, and have not obtained satisfactory

results from stars fainter than the second or third magnitude, Professor Pickering has often obtained more than 100 spectra on a single plate, many of them of stars not brighter than the seventh or eighth magnitude. By means of the second device, the necessary width of the spectrum is secured. If clockwork were employed, the spectrum of a star would be a line too narrow to show any details. Formerly, a cylindrical lens was used to widen the spectrum; but by placing the prism as above, and by suitably varying the rate of the clock, any desired width can be given to the spectrum simply by the motion of the star itself. One millimetre was found to be the best width.

The first experiments were made in May, 1885, by placing a 30° prism in front of a lens of 2½ inches aperture. No clockwork was used, the spectra being formed of the trails of the stars. In the spectrum of the pole star, over a dozen lines could be counted, and in that of *a* Lyræ, the characteristic lines were shown very clearly with an exposure of only two or three minutes. In the fall of 1885, two prisms were obtained 20 centimetres in clear aperture, and having angles of 5° and 15°, respectively. These could be placed in front of the object glass of the 8-inch photographic telescope. With this apparatus, systematic operations were begun. The research, however, proved too large for the Bache appropriation. Whereupon, Mrs. Henry Draper came forward, early in 1886, and generously offered not only to defray the expenses of the investigation as a memorial to Dr. Draper, but to put at Professor Pickering's disposal the 11-inch refractor, with its photographic corrector, with which Dr. Draper has taken many of his later stellar photographs. The investigation was thereupon extended by Professor Pickering, and divided into three parts. The first included a general survey of stellar spectra, each spectrum being photographed with an exposure of not less than five minutes. These photographs generally exhibited the spectra of all stars brighter than the sixth magnitude with sufficient distinctness for measurement. The second research related to a determination of the spectra of the fainter stars. Each photograph taken received an exposure of one hour, so that the spectra of all the stars not fainter than the eighth or ninth magnitude and included in a region 10° square were represented upon the plate. For both these investigations, the 8-inch Bache photographic telescope was employed. The third research related to a more detailed study of the spectra of the brightest stars. For this work the Henry Draper 11-inch corrected refractor was used, Mrs. Draper having provided a small observatory for it in Cambridge, and also the mounting. Four prisms were constructed, each of 15°, of which three had a clear aperture of nearly 11 inches, the fourth being somewhat smaller, the whole weighing more than 100 pounds and occupying a cubic foot of space.

The results already attained in these three directions have been satisfactory. In the first research, the first cycle, covering the entire sky from zero to 24 hours of right ascension, has been completed. This

cycle contains 257 plates, all of which have been measured, and a large part of the reduction completed. 8,313 spectra have been measured on them, nearly all of which have been identified, and the places of a greater portion of the stars brought forward to the year 1900, and entered in catalogue form. In the second cycle, which will complete the work, 64 plates have been taken, of which 51, including 2,974 spectra, have been measured and identified. In the second research, which has been carried on in the intervals when the telescope was not needed for other purposes, 99 plates, with an exposure of an hour, have been obtained, on which 4,442 spectra have been measured, in one case over 300 spectra being shown on a single plate. In both these researches taken together 15,729 spectra of bright and faint stars have been measured. In the third research, the first results of which were obtained in October last, a considerable number of excellent photographs have been obtained, the results of which can be stated only after a long series of measurements, and a careful reduction and discussion of them. Some points of interest, however, are shown on inspection. A photograph of α Cygni, taken November 26, 1886, shows that the H line is double, its two components having a difference in wave length of about one ten-millionth of a millimetre.* A photograph of Omicron Ceti shows that the lines G and H are bright, as are also four of the ultra-violet lines characteristic of spectra of the first type. The H and K lines in this spectrum are dark, showing that they probably do not belong to that series of lines. The star near X′ Orionis, discovered by Gore, in December, 1885, gives a similar spectrum, which affords additional evidence that it is a variable of the same class as O Ceti. Spectra of Sirius show a large number of faint lines beside the well-known broad lines.

Professor Pickering has also devised a new method of enlarging these original photographs, which also removes the inequalities in density in the negatives, appearing as bands parallel to the length of the spectrum. A cylindrical lens is placed close to the enlarging lens, with its axis perpendicular to the spectrum lines. In this way, the length of the spectrum is increased only five times, while its width is increased nearly one hundred; *i. e.* from 1 millimetre to about 4 inches. This arrangement greatly reduces the difficulty arising from the feeble light of the star. Until very lately, the spectra in the original negatives were made very narrow, since otherwise the intensity of the starlight would have been insufficient to produce the proper decomposition of the silver particles. The enlargement being made by daylight, the vast amount of energy then available is controlled by the original negative, the action of which may be compared to that of a telegraphic relay. The copies, therefore, represent many hundred times the original energy received from the stars.

* It has long been known that the H line is also double (bright) in the spectrum of the solar chromosphere.

The deed of trust under which this committee is acting provides "that the investigation for which it (the Henry Draper medal) is awarded, or the completed publication thereof, shall have been made since the time of the last preceding award and presentation of said medal." In consequence, the committee recommends the award to Professor Pickering, for the specific investigations in stellar photometry and photography above mentioned, which have been made since the month of April, 1885, the time of the last preceding award and presentation of the said medal. This comprises, it is believed, the whole of the photographic work done at the Harvard College Observatory, and a large and important part of the photometric work.

In the opinion of the committee, Professor Pickering has displayed in these researches a skill, ingenuity, and vigor, which entitle him to an honorable place among the scientific men of our own or of any previous age.

All of which is respectfully submitted.

GEORGE F. BARKER.
WOLCOTT GIBBS.
SIMON NEWCOMB.
CHARLES A. YOUNG.
ARTHUR W. WRIGHT.
Committee on the Henry Draper Medal.

April 21, 1887.

On the evening of April 18, 1888, at a public session of the Academy, the second Henry Draper medal was, in behalf of the Academy, presented by the president to Prof. E. C. Pickering, of the Harvard Observatory, for his work in astronomical photometry and photography.

AWARD OF THIRD DRAPER MEDAL.

At a special session of the Academy, held in Philadelphia, November 13, 1889, Mr. George F. Barker presented the following recommendation of the committee on the Henry Draper medal:

The committee on the Henry Draper medal recommend to the National Academy of Sciences the award of the Henry Draper medal to Prof. Henry A. Rowland, of Baltimore, for his researches on the solar spectrum.

This recommendation was adopted by the Academy.

THE LAWRENCE SMITH FUND.

During the April session, 1884, the president announced that the widow of Prof. J. Lawrence Smith, late an honored member of the Academy, intended to place at the disposal of the National Academy of Sciences the sum of $8,000, as a memorial fund to promote the study of meteoric bodies.

Upon recommendation of the council, the Academy adopted the following resolution:

Resolved, That the Academy hears with gratification the announcement that Mrs. J. Lawrence Smith intends to intrust to it a fund to promote the study of meteoric bodies, and hereby signifies its readiness to accept the trust.

The Academy also adopted the recommendation of the council, "that the president be authorized to communicate with Mrs. J. Lawrence Smith, and make what arrangements were necessary."

The following is the text of the deed of gift of Mrs. Smith:

DEED OF TRUST OF MRS. J. LAWRENCE SMITH.

Know all men by these presents, that I, Sarah Julia Smith, of the city of Louisville, and county of Jefferson, State of Kentucky, in consideration of the premises, and of the acceptance of the within trust by the National Academy of Sciences, and also in consideration of divers other good and valuable considerations, I, the said Sarah Julia Smith hereto moving, have given, granted, assigned, transferred, and set over, and by these presents do give, grant, assign, transfer, and set over, unto the said National Academy of Sciences, and to their successors forever, a certain fund or sum of $8,000, with the interest and income thereof, to have and to hold the same in trust nevertheless, upon the special trusts and for the uses and purposes following, to wit:

First. In trust, to invest and to reinvest the said sum of $8,000, and to keep the same invested in good and safe securities, or in such other manner as shall be, in their opinion, best for the preservation and maintenance of such fund.

Second. In trust, to use the interest and income thereof for the purpose of striking a gold medal, which shall be called the "Lawrence Smith Medal," shall be of the value of $200 in gold, and shall be struck in a die, to be selected and presented to the said National Academy of Sciences by me, the said Sarah Julia Smith. And the said medal shall be awarded and presented from time to time, by the said National Academy of Sciences, to any person in the United States of America or elsewhere, who shall make an original investigation of meteoric bodies, the results of which shall be made known to the public, such results being in the opinion of the said National Academy of Sciences of sufficient importance and benefit to science to merit such recognition; provided, however, that said medal shall not be presented or awarded more frequently than once in 2 years, and provided, also, that the investigation for which it is awarded, or the completed publication thereof, shall have been made since the time of the last preceding award and presentation of said medal.

Third. In trust, that if investigations of equal importance shall be made in regard to meteoric bodies at or about the same time in the United States of America and also in some other part of the world, each of which investigations might, in the opinion of the said Academy, entitle the investigator to be considered as a competitor for said medal, preference shall be given in the awarding thereof to investigations made by a citizen of the said United States of America.

Fourth. In trust, that if the said die shall at any time be lost, destroyed, broken, or in any manner rendered unfit for the purpose of striking the said medal, a new die shall be procured exactly similar to the one so selected and presented as aforesaid, and shall be paid for out of the interest and income of the said fund; and such sum or sums of money as shall at any time or times be necessary for the care, custody, and protection of the said die or of the said fund hereby given shall also be taken from and out of the interest and income of the said fund whenever the same shall be deemed necessary by the said National Academy of Sciences.

Fifth. In trust, that if at any time or times the interest and income of said trust fund of $8,000 shall exceed the amount necessary for the striking of said medal and the care of the said die and of the fund, such surplus over and above the sum or sums

so required for the purposes of the trust, as hereinbefore recited and set forth, shall be used in such manner as shall be selected by the National Academy of Sciences in aid of investigations of meteoric bodies, to be made and carried on by a citizen or citizens of the United States of America.

And the said National Academy of Sciences doth signify its acceptance of the said fund of $8,000, and doth engage to hold and manage the same upon the trusts and for the uses and purposes herein mentioned and set forth.

In witness whereof I, the said Sarah Julia Smith, have hereunto set my hand and seal, and the said National Academy of Sciences hath hereunto caused its corporate seal to be affixed, and these presents to be subscribed by its president, this 6th day of May, in the year 1884.

SARAH JULIA SMITH. [SEAL.]

Sealed and delivered in the presence of—
ANNIE C. NORTON.
J. H. CAPERTON. [SEAL.]

O. C. MARSH,
President of the National Academy of Sciences.

Witnesses to signature:
GEO. J. BRUSH.
E. S. DANA.

At a stated session of the Academy, held in April, 1885, the following resolutions in regard to the Smith fund were adopted upon recommendation of the council:

Resolved, That the National Academy of Sciences gratefully acknowledges the receipt of a fund of $8,000, presented in trust by Mrs. Sarah Julia Smith to promote the study of meteoric bodies; that the Academy adopts and confirms the action of its president in accepting such trust, and promises the faithful execution of the same.

Resolved, That the Academy appreciates the confidence reposed by the donor in selecting it as the trustee for executing her purpose, and her further liberality in providing dies for a suitable medal.

Resolved, That a committee of 5 members be appointed by the president to recommend to the Academy such measures as may be necessary to the proper execution of the trust.

Resolved, That the said committee be charged with the duty of preparing an expression of appreciation by the Academy of the munificence of Mrs. Smith, and of having such expression suitably engrossed and signed by the proper officers for transmission to the donor.

Resolved, That the treasurer be authorized to reserve from the income of the J. Lawrence Smith fund, $133 each year, to be invested from time to time until the invested fund is increased to $8,000, the amount intrusted to the Academy by Mrs. Smith.

COMMITTEE ON THE SMITH FUND.

The president appointed as permanent committee on the Smith fund the following members:

Wolcott Gibbs, *Chairman.*

G. J. Brush.	R. Pumpelly.
A. Hall.	L. M. Rutherfurd.

ACKNOWLEDGMENT TO MRS. SMITH.

MRS. SARAH JULIA SMITH:

MADAM: It is our duty as a committee of the National Academy of Sciences to tender to you the thanks of the Academy for the munificent donation which you have intrusted to it. With the most sincere appreciation of the spirit which dictated your gift, and with profound respect and sympathy, we now discharge the duty which has devolved upon us.

The noble and unselfish life of our lamented fellow member, Dr. J. Lawrence Smith, was devoted to science; and of the work which he did, and which confers eternal honor upon his name, no part is more deeply interesting or more permanently valuable than his researches on the chemical constitution of meteorites, researches in which he first established in these bodies the existence of hydrocarbon. His beautiful collection has become the property of one of our most prominent colleges. His name and fame are national possessions. The income of the fund which you have intrusted to the Academy, worthily bestowed, can not fail to assist materially in extending our knowledge of meteoric phenomena.

The Academy accepts the trust, which honors the giver, which recalls the lifelong services of one of its most honored members, and which promises to extend the boundaries of the science to which he was devoted. We tender to you, madam, in the name of the Academy, our grateful acknowledgments.

WOLCOTT GIBBS, *Chairman.*
G. J. BRUSH.
A. HALL.
R. PUMPELLY.
L. M. RUTHERFURD.
Committee.

July 27, 1885.

PRESENTATION OF FIRST LAWRENCE SMITH MEDAL.

In December, 1887, the committee on the Smith fund unanimously recommended that the first J. Lawrence Smith medal be awarded to Prof. Hubert A. Newton, of New Haven, Connecticut, in recognition of his eminent services in the investigation of the orbits of meteors. This recommendation was adopted by the Academy at the April meeting, 1888, and at a public session, held on the evening of April 18, 1888, the first Smith medal given by the Academy was presented to Professor Newton by the president, who, in a short address, gave the reasons for its award.

The report of the committee is as follows:

REPORT OF THE COMMITTEE.

To the National Academy of Sciences:

Professor Newton's study of the subject extends over a long series of years, and has led to results of very great popular interest as well as scientific importance. Meteors in the sense in which the word is now used have from the remotest ages attracted the attention of mankind. Observations of greater or less value have long been accumulating. Chemistry had shown that meteoric bodies which fall upon the earth contain no element not already known as a constituent of the

crust of the earth, but astronomy had not yet brought the wanderers of the heavens into a system and shown that they are moving in definite orbits, and are not distributed by chance in the celestial spaces. Professor Newton's first paper was published in 1860, and was succeeded by a number of others, the last having been read to the National Academy, in April of the present year.

From a careful analysis of the early observations of the archives, going back to the year 902, as well as of modern observations, Professor Newton showed that the connection between the November star showers of 1799 and 1833 had been concealed by the fact, that the day of the shower was moving from October 12, A. D. 902 to November 13, 1833. The shower was thus traced back over 900 years, and the persistence of this 33-year period was distinctly shown. It was also proved that the paths in which the meteors are moving about the sun must be one of five sharply defined orbits. A method of deciding which one of these orbits was the true one was suggested. Professor Adams of Cambridge (England) then showed in the manner indicated which orbit was the correct one, and so prepared the way for proving beyond question, as soon as Oppolzer published the orbit of the comet of 1886, that this comet and the November meteors belong to one system. Schiaparelli had just shown that the August meteors belonged to the same system as another comet.

In a memoir on shooting stars, published in the memoirs of the National Academy (read August 6, 1864), Professor Newton for the first time proved that the orbits of these bodies are not approximately circular like those of the planets, but that they resemble more the parabolic orbits of comets. This was the first step towards the establishment of a relationship between comets and meteors. In the same memoir, Professor Newton undertook to show how many shooting stars enter the air each day. The result of the discussion was the number 7,500,000, but later observations increase this number materially, and perhaps even double it. Another interesting and suggestive question also considered was this: As the earth moves round the sun, how thickly filled with meteorites is the space which it traverses? To this question, the answer given is, as a first approximation, 13,000 in each unit of space of the size of the earth itself.

In a subsequent paper, Professor Newton made an attempt to determine whether comets come originally from the solar system or from outside of it. The investigation was based upon the observed facts, and the results obtained are still under consideration by astronomers. The argument that the meteoric stones of our cabinets were all fragments of comets was again brought out in a lecture delivered at the Sheffield Scientific School. This again was followed by a paper on the effect upon the earth's velocity produced by small bodies passing near the earth. In this paper, it is shown that while small bodies which pass

near the earth, but do not meet it, have a real effect in stopping the earth or the moon, this effect is much too small to be sensible.

In a discussion of the Biela meteors of November 27, 1885, Professor Newton, among other facts, brought out the very interesting and important one, that the meteors left the comet since 1840, and that the disintegration of the comets furnishing meteor streams is a more rapid process than has been usually supposed.

Finally, in a paper read before the National Academy of Sciences, April 19, 1888, Professor Newton has established the following propositions:

(1) The meteorites which we have in our cabinets, and which were seen to fall, were originally (as a class, and with a very small number of exceptions) moving about the sun in orbits that had inclinations less than 90°; that is, their motions were direct and not retrograde.

(2) The reason why we have only this class of stones in our collections is not one wholly or even mainly dependent on the habits of men, nor on the times when men are out of doors, nor on the places where men live, nor on any other principle of selection acting at or after the arrival of the stones at the ground. Either the stones which are moving in the solar system across the earth's orbit move, in general, in direct orbits, or else, for some reason, the stones which move in retrograde orbits do not in general come through the air to the ground in solid form.

(3) The perihelion distances of nearly all the orbits in which these stones moved were not less than 0.5 nor more than 1.0, the earth's radius vector being unity.

In the judgment of the committee, these researches are of a very high order of merit and of interest.

WOLCOTT GIBBS.
GEORGE J. BRUSH.
RAPHAEL PUMPELLY.
ASAPH HALL.
L. M. BUTHERFURD.
Committee.

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51ST CONGRESS, 2d Session. | SENATE. | MIS. DOC. No. 60.

REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1890.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1891.

LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,

Washington, D. C., January 10, 1891.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences during the past year.

Very respectfully,

O. C. MARSH,

President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

The National Academy of Sciences was established by act of Congress in March, 1863, with power to frame its own constitution, select its own members, and provide in other respects for its continuance and successful operation.

The object of the Academy is to advance science, and especially to investigate, examine, experiment, and report on any subject of science or art whenever called upon by any department of the Government.

The Academy contains at present about 100 members, and these have all been selected for their original researches in science. They represent within their ranks nearly every department of knowledge, and their services, in accordance with the charter of the Academy, are always at the disposal of the Government, without compensation.

SESSIONS OF THE NATIONAL ACADEMY.

During the past year, the Academy has held three sessions. The first was the regular annual meeting, held in Washington, D. C., April 15 to 18, 1890; the second was a scientific session in Boston, Mass., November 11 to 13, 1890; and the third was a special session in Boston, November 12, 1890.

STATED SESSION.

Held in Washington City, April 15 to 18, 1890.

The Washington session was held in the National Museum, the president, Prof. O. C. Marsh, presiding.

The following members were present during the session:

Abbot.	Dutton.	Hyatt.	Newton, H. A.
Barker.	Gibbs, J. W.	Langley.	Pumpelly.
Bell.	Gill.	Lesley.	Putnam.
Billings.	Goode.	Marsh.	Remsen.
Boss.	Gould.	Meigs.	Rowland.
Brewer.	Hague.	Mendenhall.	Schott.
Brooks.	Hall, A.	Michelson.	Scudder.
Brush.	Hall, J.	Mitchell, S. W.	Walker.
Chandler, S. C.	Hastings.	Morse.	Watson.
Cope.	Hill, G. W.	Newcomb.	Young.

During this session, papers were read and discussed in the following order:

1. MICHELSON, A. A.: On the application of interference methods to astronomical measurements. Discussed by Messrs. Hall and Michelson.
2. TODD, D. P.; presented by the home secretary: Totality of the eclipse of 1889, December 22. Read by the home secretary.
3. SCUDDER, S. H.: Physiognomy of the American Tertiary Hemiptera. Discussed by Messrs. Cope and Morse.
4. ROWLAND, H. A.: On the spectrum of metals. Discussed by Messrs. W. Gibbs, Young, Rowland, and Michelson.
5. CHANDLER, S. C.: A system of classification of variable stars. Discussed by A. Hall, Gould, Michelson, and Chandler.
6. WOOD, H. C.: The effects of the inhalation of nitrogen, nitrous oxide, oxygen, and carbonic acid upon the circulation; with special reference to the nitrous oxides, anæsthesia, and asphyxia. Read by Mr. Billings. Discussed by Messrs. Cope and Billings.
7. BROOKS, W. C.: The budding of salpa considered in relation to the question of the inheritance of acquired characters. Discussed by Messrs. Cope and Brooks.
8. GOODE, G. BROWN, and TARLETON H. BEAN: Recent advances towards a knowledge of the fishes of the great oceanic depths. Discussed by Mr. Gill.
9. GILL, THEO.: The inter-relationships of the Ichthyopsida. Discussed by Mr. Cope.
10. LANGLEY, S. P.: On the cheapest light. Discussed by Messrs. Young, Newcomb, Langley, and Scudder.
11. PUMPELLY, R.: On the relation of secular disintegration to certain crystalline and transitional schists.
12. PUMPELLY, R.: On the structure of the Green Mountains.
13. GILL, THEO.: The Notacanthoid fishes as representatives of a peculiar order.
14. GILL, THEO.: The Halosauroid fishes typical of a special order.
15. REMSEN, IRA: Researches on the double halides.
16. REMSEN, IRA: Researches on the sulphinides.

REPORTS OF COMMITTEES.

Mr. Gould presented a report from the committee of the council on the classification of the Academy into sections. This report was referred to the council.

The chairman of the committee on ways and means to provide a fund for the Academy being absent, the president reported progress.

For the committee on publication, the home secretary stated that Part 2 of Volume IV of the memoirs had been finished, after long delays, and was now being distributed by the Smithsonian Institution; also that the report of the president for 1889, with four memoirs, was in the hands of the Senate committee. The president appointed Mr. Mendenhall to fill the vacancy existing on this committee.

Mr. Gill reported progress on the bibliography of the publications of the Academy.

On behalf of the committee on the relation of the Academy to the Government, the president stated briefly that the relations to the Government had been very cordial. Mr. Brush was appointed to fill the vacancy on this committee.

Mr. Morse expressed the opinion that members of the Academy should receive Government publications on subjects in which they were especially interested, and the president referred the matter to the committee on the relation of the Academy to the Government.

Mr. Morse presented the following resolution, which was adopted:

Resolved, That the committee on the relation of the Academy to the Government be requested to ascertain what steps are necessary to secure a distribution of Government publications to members of the National Academy, and report the same to the Academy at its next meeting.

For the board of trustees of the Watson fund, Mr. Newcomb said that there had been no formal proceedings since last year's meeting. Mr. A. Hall was appointed to fill the vacancy on this committee, caused by the death of Mr. Coffin.

ELECTIONS.

The following members were elected for the council for the ensuing year: Messr. Brush, Gould, Meigs, Newcomb, Remsen, and Walker.

RECOMMENDATIONS FROM THE COUNCIL.

The following recomendations from the council were adopted by the Academy:

1. That Mr. C. W. Shoemaker be appointed recording secretary for the present meeting.
2. That the membership fee for the ensuing year be $5.
3. That the consideration of the amendment to the constitution dividing the membership into sections be postponed until the next stated session, and that the home secretary be authorized to print copies of the report on the subject for the information of the members.

BIOGRAPHICAL MEMOIRS.

At a public session of the Academy, held on the evening of April 16, the following biographical memoirs were read:

Of Dr. James C. Dalton, by Dr. S. Weir Mitchell.

Of Professor Elias Loomis, by Prof. H. A. Newton.

Of Prof. Leo Lesquereux, by Prof. J. P. Lesley.

PRESENTATION OF THE HENRY DRAPER MEDAL.

At the same public session, April 16, the third Henry Draper gold medal was presented to Prof. H. A. Rowland, for his researches on the solar spectrum, as well as for his investigations in astronomical physics.

REPORT OF THE AUDITING COMMITTEE.

The following report of the auditing committee was presented to the Academy, and, on motion of Mr. Remsen, was adopted:

Washington, D. C., April 16, 1890.

To the President of the National Academy of Sciences:

SIR: The committee appointed to audit the treasurer's accounts, and to compare them with the report made by the committee on the securities held by the Academy, respectfully report that they have examined the books and the accounts of the treasurer, and have compared the vouchers with the disbursements reported, and have compared the receipts with the record of dues received from members, and with the record of interest received from invested funds of the Academy, and that they have also compared the accounts of sales of bonds and reinvestments in loans, and find the same to be correct.

T. C. MENDENHALL.
SAM. H. SCUDDER.
ARNOLD HAGUE.

TREASURER'S REPORT.

April 15, 1890.

To the President of the National Academy of Sciences:

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 15, 1890.

1. *General account, April* 16 1889, *to April* 15, 1890.

RECEIPTS.

Balance brought forward from April 16, 1889	$410.77
Amount of invested income	*500.00
Income received during the year	460.26
Total to be accounted for	1,371.03

DISBURSEMENTS.

Disbursed during the year	417.67
Balance on hand	453.36
Invested income on hand	*500.00
Actual balance after deducting outstanding obligations	953.36

2. *The Bache trust fund.*

RECEIPTS.

Balance brought forward from April 16, 1889	$3,500.95
Income received during the year	1,632.45
Total to be accounted for	5,133.40

* Invested in District of Columbia 3.65 bonds.

DISBURSEMENTS.

Disbursed during the year	$599.71
Balance on hand	4,533.69
Actual balance after deducting outstanding obligations	1,639.45

3. *The Watson trust fund.*

RECEIPTS.

Balance brought forward from April 16, 1889	$298.39
Amount of invested income	*1,500.00
Income received during the year	747.57
Total to be accounted for	2,545.96

DISBURSEMENTS.

Disbursed during the year	100.00
Balance on hand	945.96
Invested income on hand	*1,500.00
Actual balance after deducting outstanding obligations	2,445.96

4. *The Henry Draper medal fund.*

RECEIPTS.

Balance brought forward from April 16, 1889	$740.31
Income received during the year	167.52
Total to be accounted for	907.83

DISBURSEMENTS.

Disbursed during the year	†463.88
Balance on hand	443.95

5. *The J. Lawrence Smith medal fund.*

RECEIPTS.

Balance brought forward from April 16, 1889	$1,237.78
Income received during the year	239.22
Total to be accounted for	1,477.00

DISBURSEMENTS.

Disbursed during the year	†540.00
Balance on hand	937.00

Very respectfully,

J. S. BILLINGS,
Treasurer National Academy of Sciences.

* Invested in District Columbia 3.65 bonds.
† Reserve fund: Draper, $260; Smith, $540.

REPORT OF THE COMMITTEE ON SECURITIES HELD BY THE ACADEMY.

The committee, Messrs. Schott and Goode, appointed to verify the securities held by the Academy, presented the following report, which was approved:

1. *General fund.*

District of Columbia 3.65 bonds	$500.00

2. *Bache trust fund.*

United States 4 per cent. bonds, registered	$3,850.00	
Philadelphia 6 per cent. bonds, registered	600.00	
United States 4½ per cent bonds, registered	42,100.00	
Davenport 6 per cent. bonds, coupon	1,000.00	
		47,550.00

Deed for 160 acres of Missouri lands to A. D. Bache, not yet transferred to the name of the Academy.

3. *Joseph Henry fund.*

An agreement with the Pennsylvania Company for insurance on lives and granting annuities, as to the final disposition of the Joseph Henry fund of $40,000. The above will not be available until the decease of all of Professor Henry's children.

4. *Watson trust fund.*

Certificate for one hundred and thirty-four shares of the capital stock of the Michigan Life Insurance Company	$6,700.00	
District of Columbia 3.65 bonds	1,500.00	
United States 4½ per cent. bonds, registered	6,200.00	
United States 4 per cent. bonds, registered	850.00	
		15,250.00

5. *Henry Draper medal fund.*

United States 4 per cent. bonds, registered	5,000.00

Deed of trust of Mary Anna Palmer Draper to the National Academy of Sciences.

6. *J. Lawrence Smith medal fund.*

United States 4½ per cent. bonds, registered	7,200.00

Deed of trust of Sarah Julia Smith to the National Academy of Sciences.

Amount of available securities	75,500.00

NEW MEMBERS.

The following new members were elected: Messrs. George L. Goodale, Russell H. Chittenden, Thomas L. Casey, and Richmond M. Smith.

NOMINATIONS.

Twelve nominations for membership in the Academy were read. These will be acted upon at the next stated session.

INVITATIONS.

The members of the Academy received an invitation to accept the privileges of the Cosmos Club during their stay in Washington.

The U. S. Commissioner of Fish and Fisheries also extended an invitation to members of the Academy and their friends, to visit the marine and fresh-water aquaria in the Commission building, near the National Museum.

Mr. Langley invited the members of the Academy, with their families and friends, to inspect the new physical apparatus in the small building near the Smithsonian Institution.

Mr. J. P. Lesley, of Philadelphia, exhibited a geological model of the condition of the upper surface of the Medina sandstone in the State of Pennsylvania.

DEATH OF MEMBER.

The president announced the death, since the last meeting, of Prof. J. H. C. Coffin, one of the original members of the Academy. Professor Coffin died January 8, 1890. Mr. Gould was appointed to prepare the biographical memoir.

The Academy adjourned April 18, 1890, to meet in Boston, Mass., in scientific session, November 11, 1890.

SCIENTIFIC SESSION.

HELD IN BOSTON, MASS., NOVEMBER 11 TO 13, 1890.

A scientific session, for the reading of papers only, having been called by the council, as announced at the April meeting, the Academy met in the lecture room of the Boston Society of Natural History, Boston, Mass., on November 11, 1890. The meetings were continued on the 12th and 13th.

The president, Prof. O. C. Marsh, presided, and the following members were present during the session:

Abbot.	Farlow.	Johnson.	Powell.
Barker.	Gibbs, W.	Langley.	Pumpelly.
Boss.	Gilbert.	Lovering.	Putnam.
Bowditch.	Gill.	Marsh.	Rogers, W. A.
Brewer.	Gould.	Mendenhall.	Scudder.
Brush.	Hague.	Michelson.	Trowbridge, J.
Casey.	Hall, A.	Mitchell, H.	Walker.
Chandler, C. F.	Hall, J.	Morse.	Watson.
Chandler, S. C.	Hill, H. B.	Newberry.	White.
Chittenden.	Hyatt.	Newton, H. A.	
Crafts.	Jackson.	Pickering.	

The following papers were read and discussed:

1. CHITTENDEN, R. H.: On the Primary Cleavage products formed in the digestion of the Albuminoid Gelatin. Discussed by Mr. W. Gibbs.
2. PICKERING, E. C.: On the Classification and Distribution of the Stellar Spectra.
3. CATLIN, R.; presented by S. Weir Mitchell: On the Relation of Atmospheric Electricity, Magnetic Storms, and Weather Elements, to a case of Traumatic Neuralgia. Read by title.
4. BOWDITCH, H. P.: On the Growth of Children studied by Galton's method of Percentile Grades.
5. TROWBRIDGE, J.: On Electrical Oscillations in Air, together with Spectroscopic Study of the motions of Molecules in Electrical Discharges. Discussed by Mr. Michelson.
6. CROSS, C. R.; presented by F. A. Walker: Some considerations regarding Helmholtz's Theory of Dissonance.
7. ROGERS, W. A.: A critical Study of a Combined Meter and Yard upon a surface of gold, the Meter having subdivisions to two millimetres, and the Yard to tenths of inches.
8. ROGERS, W. A.: On Evaporation as a disturbing Element in the determination of Temperatures. Mr. Rogers's papers were discussed by Messrs. Crafts, Gould, and Pickering.
9. FEWKES, J. W.; presented by A. Hyatt: On the use of the Phonograph in the Study of the Languages of the American Indians. Discussed by Mr. Powell.
10. WALKER, F. A.: On the Probable Loss in the Enumeration of the Colored People of the United States, at the Census of 1870. Discussed by Messrs. Scudder and Newton.
11. NEWTON, H. A.: On the Capture of Periodic Comets by Jupiter. Discussed by Messrs. Boss and Chandler.
12. OSBORNE, T. B.; presented by S. W. Johnson: On the Proteids of the Oat Kernel. Discussed by Messrs. Gibbs and Johnson.
13. CHANDLER, S. C.: On the present aspect of the problems concerning Lexell's comet. Discussed by Messrs. Boss, Gould, and Newton.
14. NEWBERRY, J. S.: The Great Falls Coal Field, Montana; its geological age and relations. Discussed by Mr. White.
15. GIBBS, W.: Notes on the separation of the oxides in cerite, samarskite, and gadolinite. Discussed by Messrs. Barker and Chandler.
16. GILL, T.: On the relationships of the Cyclopteroidea.
17. DOLBEAR, A. E.; presented by J. Trowbridge: On the origin of electric-magnetic waves

SPECIAL SESSION.

HELD IN BOSTON, MASS., NOVEMBER 12, 1890.

A special session of the Academy having been called by the council, in accordance with Article III, section 1, of the constitution, the Academy convened at the Boston Society of Natural History, November 12, 1890, the president, Prof. O. C. Marsh, presiding.

The president submitted his annual report to Congress, as far as completed, and the following recommendation from the council was adopted by the Academy:

Resolved, That the president be authorized to include in his report the proceedings of the present meeting; and, also, any reports to the Government submitted to the Academy during the year.

INVESTIGATION OF THE NORTH MAGNETIC POLE.

The president read a letter from the Secretary of the Treasury, dated May 22, 1890, requesting the appointment of a committee composed of members of the National Academy of Sciences, or others familiar with the problems involved, to formulate a plan for a systematic investigation of the north magnetic pole. In accordance with this request, the president stated that he had appointed the following committee:

Prof. S. P. Langley, Secretary, Smithsonian Institution, *Chairman.*
Gen. Henry L. Abbot, U. S. Army.
Prof. William P. Trowbridge, Columbia College.
Prof. Alfred M. Mayer, Stevens Institute.
Prof. Charles A. Schott, U. S. Coast and Geodetic Survey.
Prof. John Trowbridge, Harvard University.
Prof. Charles Carpmael, University of Toronto.

UNIFORMITY OF MEASURES IN PHYSICAL APPARATUS.

The following resolution, proposed by Mr. Langley and recommended by the council, was adopted by the Academy:

Resolved, That the president appoint a committee of three members to secure such uniformity of measures in physical apparatus as will promote interchangeability of their parts.

The president appointed the following members as this committee:
S. P. Langley, *Chairman,* T. C. Mendenhall, E. C. Pickering.

The president and home secretary explained the condition of the printing of the memoirs of the Academy. Mr. Gould moved that the committee on printing be directed to omit those memoirs that were not found to be in a form suitable for immediate printing. This was seconded by Mr. Morse and adopted by the Academy.

ABSTRACT OF TREASURER'S REPORT.

The home secretary read an abstract of a report of the treasurer, dated November 10, 1890. This report showed the following available balances:

General fund	$622.14
Bache fund	840.25
Watson fund	2,920.13
Draper fund	584.69
Smith fund	1,181.29
Total	6,148.50

THE WATSON MEDAL.

Mr. Gould presented the following report from the board of trustees of the Watson fund, which was approved by the Academy:

Boston, November 12, 1890.

To the National Academy of Sciences:

The board of trustees of the Watson fund respectfully recommend to the Academy that a Watson medal be awarded to Dr. Arthur Auwers,

of Berlin, for his contributions to stellar astronomy, including his superintendency of the zone observations of the Astronomische Gesellschaft, his researches on variable proper motions, and his re-discussion of Bradley's observations.

The grounds for this award will be presented to the Academy in due time.

Very respectfully,

SIMON NEWCOMB.
B. A. GOULD.
ASAPH HALL.

The special session then adjourned.

RESOLUTIONS.

Mr. Gibbs offered the following resolutions, which were unanimously adopted by the Academy:

Resolved, That the thanks of the Academy be returned to the officers of the Boston Society of Natural History and of the Massachusetts Institute of Technology for the excellent accommodations which have done so much to render the meeting of the Academy successful as well as agreeable.

Resolved, That the Academy acknowledges, with grateful appreciation, the abounding hospitality of the president and fellows of Harvard University, and the opportunity which has been offered to its members to visit the beautiful collections and admirable equipment of the university.

Resolved, That the Academy returns thanks to the St. Botolph Club for the use of its club house, feeling that literature and art are the sisters of science.

Resolved, That the Academy, warmly sympathizing with the higher education of woman, gratefully appreciates the opportunity of visiting the Harvard Annex.

Resolved, That the invitation of the trustees of the Museum of Fine Arts was a delicate and graceful attention, which demands an expression of the sincere thanks of the Academy.

Resolved, That the Academy returns thanks to the Thursday Evening Club and to Mr. Montgomery Sears for the most agreeable invitation to meet with the club, an invitation the more acceptable in that an honored president of the Academy was also president of the Thursday Evening Club.

Resolved, That the hearty thanks of the Academy are tendered to the members of the local committee for their most efficient, thoughtful, and generous provision for the comfort and convenience of the members.

DEATH OF MEMBER.

The president announced the death of Prof. C. H. F. Peters, a member of the Academy, who died July 18, 1890, at Clinton, N. Y. Mr. Charles A. Schott was appointed to prepare the biographical memoir.

The Academy adjourned to meet in Washington on the third Tuesday in April, 1891.

Respectfully submitted.

O. C. MARSH,
President of the National Academy of Sciences.

APPENDICES.

APPENDIX A.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. H. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. LeConte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Peirce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution of the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council, shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its session next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those of the transaction of business, closed.

APPENDIX B.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875, April 21, 1881, April 19, 1882, April 18, 1883, and April 19, 1888.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States, on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I. OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution of the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council, shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its session next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

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SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those of the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special meetings may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election for officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected, and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he received two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president, and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be, at all times, at the disposition of the Government, upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation, submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States; or, with the approval of the council, in State bonds, or first mortgage bonds, or real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receives two-thirds of the votes cast, it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the member were present.

RULES.

I. In the absence of any officer, a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected by a plurality of members present to assist the home secretary in keeping the records of the session.

XXII. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXIII. Any rule of the Academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, *ex officio*, a member of all Government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1890.

	Expiration of term.
MARSH, O. C., *President*	April, 1895
LANGLEY, S. P., *Vice-President*	April, 1895
GIBBS, WOLCOTT, *Foreign Secretary*	April, 1892
HALL, A., *Home Secretary*	April, 1895
BILLINGS, JOHN S., *Treasurer*	April, 1893

ADDITIONAL MEMBERS OF COUNCIL, 1890–'91.

BRUSH, G. J.
GOULD, B. A.
MEIGS, M. C.
NEWCOMB, S,
REMSEN, IRA.
WALKER, F. A.

COMMITTEES OF THE ACADEMY.

On Ways and Means to Provide a Fund for the Academy.

ROGERS, FAIRMAN, *Chairman.*
CHANDLER, C. F.
MARSH, O. C.
MITCHELL, S. WEIR.
PUMPELLY, R.

On Weights, Measures, and Coinage.

GIBBS, WOLCOTT.
HILGARD, J. E.
MEIGS, M. C.
NEWCOMB, S.
NEWTON, H. A.
PEIRCE, C. S.
TROWBRIDGE, W. P.

On the Election of Foreign Associates.

GIBBS, WOLCOTT, *Chairman.*
DANA, J. D.
GOULD, B. A.
HALL, A.
NEWCOMB, S.

On Reserving Public Lands on and near Mount Whitney, California, for Scientific Purposes.

LANGLEY, S. P., *Chairman.*
BREWER, W. H.
POWELL, J. W.

On Publication.

THE HOME SECRETARY.
BILLINGS, J. S.
MENDENHALL, T. C.
NEWCOMB, S.
POWELL, J. W.

On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.
BRUSH, G. J.
HILGARD, J. E.
MEIGS, M. C.
POWELL, J. W.

On Investigation of the North Magnetic Pole.

LANGLEY, S. P., *Chairman.*
ABBOT, H. L.
TROWBRIDGE, W. P.
MAYER, A. M.
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TROWBRIDGE, J.
CARPMAEL, C.

On Uniformity of Measures in Physical Apparatus.

LANGLEY, S. P., *Chairman.*
MENDENHALL, T. C.
PICKERING, E. C.

TRUST FUNDS.

Board of Direction of the Bache Fund.

DANA, J. D.
HILGARD, J. E.
GIBBS, W.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.*
GOULD, B. A.
HALL, A.

The Henry Draper Fund.

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HALL, A.
PUMPELLY, R.
RUTHERFURD, L. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY, 1891.

		Date of election.
ABBE, CLEVELAND	*Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A.	*Army Building, New York City.*	1872
ALLEN, J., ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	3909 *Locust St., Philadelphia, Pa.*	1876
BARTLETT, WILLIAM H. C	75 *Locust Hill Ave., Yonkers, N. Y.*	——
BELL, A. GRAHAM	*Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*Washington, D. C.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Cambridge, Mass.*	1887
BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BROWN-SEQUARD, CHARLES E	*Paris, France.*	1868
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CASEY, THOMAS L., U. S. A	*Washingon, D. C.*	1890
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	16 *Craigie St., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*Whitestone, Long Island, N. Y.*	1884
COOKE, JOSIAH P	*Cambridge, Mass.*	1872
COPE, EDWARD D	2100 *Pine St., Philadelphia, Pa.*	1872
COUES, ELLIOTT	*Washington, D. C.*	1877
CRAFTS, JAMES M	*Commonwealth ave., Boston, Mass.*	1872
DANA, EDWARD S	*New Haven, Conn.*	1884
DANA, JAMES D	*New Haven, Conn.*	——
DAVIDSON, GEORGE	*San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Washington, D. C.*	1884
FARLOW, W. G	*Cambridge, Mass.*	1879
FERREL, WILLIAM	1641 *Broadway, Kansas City, Mo.*	1868
GENTH, FREDERICK A	*W. Philadelphia, Pa.*	1872
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
GOODE, G. BROWN	*Washington, D. C.*	1888
GOULD, BENJAMIN A	*Cambridge, Mass.*	——
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH, U. S. N	*Washington, D. C.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Oakland, Cal.*	1872
HILGARD, JULIUS E	*Washington, D. C.*	——
HILL, GEORGE W	*Washington, D. C.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*San José, California.*	1885

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BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BROWN-SEQUARD, CHARLES E	*Paris, France.*	1868
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CASEY, THOMAS L., U. S. A	*Washingon, D. C.*	1890
CHANDLER, CHARLES F	*New York City.*	1874
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DANA, EDWARD S	*New Haven, Conn.*	1884
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DAVIDSON, GEORGE	*San Francisco, Cal.*	1874
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GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
GOODE, G. BROWN	*Washington, D. C.*	1888
GOULD, BENJAMIN A	*Cambridge, Mass.*	——
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH, U. S. N	*Washington, D. C.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Oakland, Cal.*	1872
HILGARD, JULIUS E	*Washington, D. C.*	——
HILL, GEORGE W	*Washington, D. C.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*San José, California.*	1885

		Date of election.
HUNT, T. STERRY	*Montreal, Canada.*	1873
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*New Haven, Conn.*	1866
KING, CLARENCE	62 *Cedar St., New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LEIDY, JOSEPH	2125 *Spruce St., Philadelphia, Pa.*	—
LESLEY, J. PETER	1008 *Clinton St., Philadelphia, Pa.*	—
LECONTE, JOHN	*Berkeley, Cal.*	1878
LECONTE, JOSEPH	*Berkeley, Cal.*	1875
LOVERING, JOSEPH	*Cambridge, Mass.*	1873
MARSH, O. C	*New Haven, Conn.*	1874
MAYER, ALFRED M	*Hoboken, N. J.*	1872
MEIGS, MONTGOMERY C., U. S. A	*Washington, D. C.*	1865
MENDENHALL, THOMAS C	*Washington, D. C.*	1887
MICHAEL, ARTHUR	*Somerville, Mass.*	1889
MICHELSON, ALBERT A	*Worcester, Mass.*	1888
MITCHELL, HENRY	*Boston, Mass.*	1885
MITCHELL, S. WEIR	1524 *Walnut St., Philadelphia, Pa.*	1865
MORSE, EDWARD S	*Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWBERRY, J. S	*New York City.*	—
NEWCOMB, SIMON, U. S. N	*Washington, D. C.*	1869
NEWTON, H. A	*New Haven, Conn.*	—
NEWTON, JOHN, U. S. A	*New York City.*	1876
OLIVER, JAMES E	*Ithaca, N. Y.*	1872
PACKARD, A. S	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*U. S. Coast Survey, Washington, D. C.*	1877
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs Ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	147 *S. Fourth St., Philadelphia, Pa.*	—
ROGERS, WILLIAM A	*Waterville, Me.*	1885
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
RUTHERFURD, LEWIS M	175 *Second Ave, New York City.*	—
SCHOTT, CHARLES A	*Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	1600 *Hamilton St., Philadelphia, Pa.*	1873
SMITH, RICHMOND M	*New York City.*	1890
SMITH, SIDNEY I	*New Haven, Conn.*	1864
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
TROWBRIDGE, WILLIAM P	*New York City.*	1872
TRUMBULL, J. H	*Hartford, Conn.*	1872
VERRILL, A. E	*New Haven, Conn.*	1872
WALKER, FRANCIS A	*Boston, Mass.*	1878
WATSON, SERENO	*Cambridge, Mass.*	1869
WHITE, CHARLES A	*Washington, D. C.*	1889
WOOD, HORATIO C	1925 *Chestnut St., Philadelphia, Pa.*	1879
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

HONORARY MEMBERS.

AGASSIZ, ALEXANDER ..... *Cambridge, Mass.*
LONGSTRETH, MIERS F ..... *Derby, Pa.*
LYMAN, THEODORE ..... *Brookline, Mass.*

DECEASED MEMBERS.

	Date of death.
*AGASSIZ, LOUIS	Dec. 14, 1873
*ALEXANDER, J. H	March 2, 1867
*ALEXANDER, STEPHEN	June 25, 1883
*BACHE, ALEXANDER DALLAS	Feb. 14, 1867
*BAIRD, SPENCER F	Aug. 19, 1887
BARNARD, J. G	May 14, 1882
BARNARD, F. A. P	April 27, 1889
*CASWELL, ALEXIS	Jan. 8, 1887
*CHAUVENET, WILLIAM	Dec. 13, 1870
CLARK, HENRY JAMES	July 1, 1873
COFFIN, JAMES H	Jan. 6, 1873
COFFIN, J. H. C	Jan. 8, 1890
COOK, GEORGE H	Sept. 22, 1889
*DALTON, J. C	Feb. 2, 1889
DAVIS, CHARLES H	Feb. 18, 1877
*DRAPER, HENRY	Nov. 20, 1882
*DRAPER, JOHN W	Jan. 4, 1882
*EADS, JAMES B	Mar. 8, 1887
ENGELMANN, GEORGE	Feb. 11, 1884
*FRAZER, JOHN FRIES	Oct. 12, 1872
*GABB, WILLIAM M	May 30, 1878
GILLISS, JAMES MELVILLE	Feb. 9, 1865
*GOULD, AUGUSTUS A	Sept. 15, 1866
*GRAY, ASA	Jan. 30, 1888
*GUYOT, ARNOLD	Feb. 8, 1884
HAYDEN, F. V	Dec. 22, 1887
*HENRY, JOSEPH	May 13, 1878
*HADLEY, JAMES	Aug. 1, 1864
*HITCHCOCK, EDWARD	Feb. 27, 1864
*HOLBROOK, J. E	Sept. 8, 1871
*HUBBARD, J. S	Aug. 16, 1863
*HUMPHREYS, A. A	Nov. 28, 1883
*HALDEMAN, S. S	Sept. 10, 1880
*KIRTLAND, JARED P	Dec. 10, 1877
*LANE, J. HOMER	——, 1880
*LECONTE, JOHN L	Nov. 15, 1883
*LESQUEREUX, LEO	Oct. 25, 1889
*LOOMIS, ELIAS	Aug. 16, 1889
*MAHAN, D. H	Sept. 16, 1871
*MARSH, G. P	July 23, 1882
*MEEK, F. B	Dec. 21, 1877
*MORGAN, LEWIS H	Dec. 14, 1881
*NORTON, WILLIAM A	Sept. 21, 1883
PETERS, C. H. F	July 18, 1890
*POURTALES, L. F	July 17, 1880
RODGERS, JOHN	May 5, 1882
ROGERS, ROBERT E	Sept. 7, 1884
*ROGERS, WILLIAM B	May 30, 1882
*SAXTON, JOSEPH	Oct. 26, 1873
*SILLIMAN, BENJ., SR	Nov. 24, 1864

UNITED STATES COAST AND GEODETIC SURVEY,
Washington, D. C., April 28, 1890.

SIR: The importance of a re-determination of the geographical position of the North Magnetic Pole has long been recognized by all interested in the theory of the earth's magnetism or its application. The point as determined by Ross in the early part of this century was not located with that degree of accuracy which modern science demands and permits, and besides it is altogether likely that its position is not a fixed one. Our knowledge of the secular variation of the magnetic needle would be greatly increased by better information concerning this magnetic pole, and in my judgment, it would be the duty of the Government to offer all possible encouragement to any suitable organized exploring expedition which might undertake to seek for this information. I am informed that such an expedition is now contemplated, and in order that such coöperation and encouragement as may be deemed advisable on the part of the Coast and Geodetic Survey may lead to the best possible results, I respectfully request that you communicate with the President of the National Academy of Sciences and ask that a committee composed of members of that body, or others who are familiar with the difficult problems involved, be appointed to formulate a plan or scheme for carrying out a systematic search for the North Magnetic Pole, in accordance with which, the Survey might render such assistance as may be considered possible and desirable.

I am, respectfully yours,

T. C. MENDENHALL,
Superintendent.

The SECRETARY OF THE TREASURY.

YALE UNIVERSITY,
New Haven, Conn., June 16, 1890.

SIR: I have the honor to acknowledge the receipt of your communication of May 22, 1890, containing a request for the appointment of a committee composed of members of the National Academy of Sciences, or others familiar with the problems involved, to formulate a plan for a systematic investigation of the North Magnetic Pole. A letter from the Superintendent of the Coast and Geodetic Survey, dated April 28, 1890, explaining more fully the object of the proposed exploration, was inclosed with your communication.

In reply, I have the honor to inform you that, in accordance with this request, I have appointed the following committee:

Prof. S. P. Langley, Secretary, Smithsonian Institution, ***Chairman.***
Gen. Henry L. Abbot, U. S. Army.
Prof. William P. Trowbridge, Columbia College.
Prof. Alfred M. Mayer, Stevens Institute.
Prof. Charles A. Schott, U. S. Coast and Geodetic Survey.
Prof. John Trowbridge, Harvard University.
Prof. Charles Carpmael, University of Toronto.

The members of this committee are all familiar with the important questions to be solved, and will give the subject careful consideration.

Very respectfully,

O. C. MARSH,
President, National Academy of Sciences.

The SECRETARY OF THE TREASURY.

PRELIMINARY REPORT.

Boston, November 12, 1890.

SIR: Referring to your letter of the 16th of June and to its inclosure of a letter from the Secretary of the Treasury requesting the appointment of a committee to formulate a plan for the investigation of the Magnetic North Pole; and also inclosing a letter from the Superintendent of the Coast and Geodetic Survey; I have the honor to state that the committee has met, and that, having laid before them the communication in question, they have instructed me to report as follows:

The committee wish to state that, in their opinion, a knowledge of the exact position of the Magnetic North Pole is not so desirable as a study of the changes in the magnetic elements to be obtained from a cordon of stations, stretching from Alaska to Newfoundland, supplemented also by stations in Siberia, which might be established by the Russian Government in connection with that of the United States Government.

Since, however, the language of the communications before the committee restricts the question to the best method of determining the exact position of the Magnetic North Pole, they feel that more definite information in regard to the nature of the country in the region to be investigated should be laid before them. They believe that this information can best be obtained from those who have visited the region in question, and that the committee at present can merely make general suggestions recommending the occupation of a cordon of stations in the neighborhood of the line of dip of 89°; for instance, on Prince of Wales Land, Boothia, near Point Ogle, and on the west side of Victoria Straits.

The committee, however, wish to emphatically state that they only recommend the above stations if they prove accessible. They have no information as to their accessibility, and they therefore express no opinion upon this point.

They desire to state that, in their opinion, whatever points are occupied, or whatever system is adopted, it is of importance to secure simultaneous observations at all the stations; and further that the character of the apparatus to be employed is of such consequence that the committee reserve the discussion of it for a later and more deliberate report.

Your obedient servant,

S. P. LANGLEY,
Chairman.

Prof. O. C. MARSH,
President of the National Academy of Sciences.

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O

REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1891.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1892.

LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 25, 1892.

SIR: In conformity with the requirements of the act of incorporation approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences during the past year.

Very respectfully,

O. C. MARSH,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

The National Academy of Sciences was established by act of Congress in March, 1863, with power to frame its own constitution, select its own members, and provide in other respects for its continuance and successful operation.

The object of the Academy is to advance science, and especially to investigate, examine, experiment, and report on any subject of science or art whenever called upon by any department of the Government.

The Academy contains at present about one hundred members, and these have all been selected for their original researches in science. They represent within their ranks nearly every department of knowledge, and their services, in accordance with the charter of the Academy, are always at the disposal of the Government without compensation.

SESSIONS OF THE NATIONAL ACADEMY.

During the past year the Academy has held three sessions. The first was the regular annual meeting, held in Washington, D. C., April 21 to 24, 1891; the second was a scientific session in New York, November 10 to 12, 1891, and the third was a special session in New York, November 11, 1891.

STATED SESSION.

HELD IN WASHINGTON CITY, APRIL 21 TO 24, 1891.

The Washington session was held in the National Museum: the president, Prof. O. C. Marsh, presiding.

The following members were present during the session:

Abbe,	Gilbert,	King,	Powell,
Barker,	Gill,	Langley,	Putnam,
Billings,	Goode,	Marsh,	Remsen,
Boss,	Gould,	Mayo-Smith,	Rowland,
Brewer,	Hague,	Meigs,	Schott,
Brush,	Hall, A.,	Michelson,	Walker,
Chandler, S. C.,	Hill, G. W.,	Morse,	White,
Cope,			

At this meeting the following papers were read and discussed:

1. PACKARD, A. S.: Further Studies on the Brain of *Limulus polyphemus*. (Read by Mr. Gill.)

2. LANGLEY, S. P.: On Aerodromics. Discussed by Messrs. Brewer and Langley.

3. BIGELOW, F. H.; presented by S. Newcomb: The Solar Corona, an instance of the Newtonian Potential in the case of Repulsion.

4. BILLINGS, J. S.: Report on the Human Bones of the Heminway Collection in the U. S. Army Medical Museum, prepared by Dr. Washington Matthews, U. S. Army. Discussed by Messrs. Putnam, Morse, Cope, Brewer, and Marsh.

5. MICHELSON, A. A.: Application of Interference Methods to Spectroscopic Measurements. Discussed by Messrs. Rowland and Michelson.

6. PRITCHETT, H. S.; presented by A. Hall: The Corona from Photographs of the Eclipse of January 1, 1889.

7. BOSS, LEWIS: Stellar Motion Problems.

8. REMSEN, IRA: Effect of Pressure and Temperature on the Decomposition of Diazo Compounds.

9. REMSEN, IRA: Researches on the Double Halides. Discussed by Messrs. Barker and Remsen.

10. LEA, M. CAREY; presented by Ira Remsen: Allotropic Silver. Discussed by Mr. Barker.

11. LEA, M. CAREY; presented by Ira Remsen: Note on a paper by M. G. Lippmann.

12. ROWLAND, H. A.: On the Yttrium Earths, and a Method of making Pure Yttrium. (Read by title.)

13. COPE, E. D.: On the Distribution of Colors in certain North American Reptiles. (Read by title.)

14. GILL, THEO.: The Taxonomy of the Apodal Fishes.

15. BROOKS, W. K., and CONKLIN, E. G.: Researches on the Embryology of Mollusks. (Read by title.)

HOME SECRETARY'S REPORT.

The home secretary submitted the following report for the past year:

APRIL 21, 1891.

The printing of volume V of the Memoirs of the Academy has been ordered by Congress, and these are now in the hands of the Public Printer. This volume should be printed during the coming summer.

The annual reports of the president of the Academy for 1889 and 1890 have recently been printed and have also been distributed to the members.

The Academy is much indebted to the Smithsonian Institution for sending out the memoirs and reports.

RECOMMENDATIONS FROM THE COUNCIL.

The following recommendations from the council were adopted by the Academy:

1. That the membership fee for the ensuing year be fixed at $5.

2. That the following resolution regarding the use of the Smith and Draper funds be adopted by the Academy:

Resolved, That it is the opinion of the Academy that the power to decide as to what investigations shall be made at the expense of the incomes of the J. Lawrence Smith or of the Draper funds can not be delegated by the Academy, and that applications for and from these funds should be forwarded to the Academy by the standing committees on these funds, with their recommendation in each case.

ELECTIONS.

Mr. F. A. Walker was elected vice-president for a term of six years to fill the vacancy caused by the resignation of Mr. Langley.

The following members were elected for the council for the ensuing year: Messrs. Brush, Gould, Langley, Meigs, Newton, and Remsen.

REPORTS OF COMMITTEES.

For the committee on ways and means to provide a fund for the Academy, the president stated that Messrs. Fairman Rogers and S. Weir Mitchell had the matter in hand, and were making efforts to secure such a fund.

Mr. Meigs reported that the committee on weights, measures, and coinage, had not met during the past year. Mr. Gould was appointed to fill the vacancy caused by Mr. Hilgard's resignation.

Mr. Gould, for the committee on the election of foreign associates, recommended the election of Messrs. J. S. Stas, of Brussels, and Carl Gegenbaur, of Heidelberg. This recommendation was adopted by the Academy.

Mr. Powell stated that, during the past three or four years, efforts had been made before Congress to secure reservations of public lands in the West for scientific purposes. These efforts had finally proved successful, and one hundred reservations are now being prepared, under his direction, Mt. Whitney being among the number.

Mr. Gill reported progress on the publications of the Academy.

In behalf of the committee on the Relation of the Academy to the Government, the president said that these relations had been cordial, though not extensive during the past year. Mr. Billings was appointed to fill the vacancy in this committee.

Mr. Morse called attention to the desirability of obtaining Government publications for members of the Academy. The president stated that, although the committee had not met since the matter was referred to them, efforts would be made to secure these publications if possible.

The president made a statement as to what had been done by the committee on the investigation of the north magnetic pole.

The home secretary read a report from the chairman of the board of direction of the Bache fund, regarding the appropriations made from this fund since the last report. Mr. J. E. Hilgard having resigned from this board, Mr. B. A. Gould was elected to fill the vacancy.

As some confusion had existed in regard to the trust funds of the Academy, the president stated that he had included the various deeds of gift, together with their results, in his report to Congress for 1889.

Mr. Gould read a report from the trustees of the Watson fund, recommending that the third Watson medal be awarded to Dr. Arthur Auwers, of Berlin. This report was accepted by the Academy. (See p. 8.)

For the board of trustees of the Draper fund, the chairman, Mr. Barker, said that the last medal was presented at the Washington meeting, April, 1890, and that a recommendation for the next award would probably be made at the next autumn meeting.

PRESENTATION OF THE JAMES WATSON MEDAL.

At the close of the scientific session, April 22, 1891, the Watson gold medal and with it the sum of $100 in gold were presented to Dr. Arthur Auwers, of Berlin, for his contributions to stellar astronomy.

As Dr. Auwers was not present at this meeting, Mr. Gould was instructed to forward the medal and $100 in gold to him, through the German embassy in Washington.

REPORT OF THE TRUSTEES OF THE WATSON FUND.

To the National Academy of Sciences:

At the last stated session of the Academy the trustees proposed that the Watson medal should be awarded to Dr. Arthur Auwers, of Berlin, for his researches in sidereal astronomy, including the new reduction of Bradley's observations. It now becomes the duty of the trustees to set forth the grounds on which this award is made.

The work of Dr. Auwers in astronomy shows the general tendency of the age towards the development and utilization of knowledge, rather than the search after brilliant discoveries. Every science, as it grows in refinement, becomes more and more in need of investigations and measures of precision. The advance of astronomy is marked by continuous efforts to improve the construction of instruments, to make measurements more precise, and to adopt such methods of observing and investigating that error shall be reduced to a minimum. This advance is well seen in the steps through which that branch of practical astronomy, which includes the application of the telescope to celestial measurements, has reached its present state.

When the astronomer of to-day examines the observations of his predecessors, to discover those which are sufficiently precise for his investigations, he generally finds that they commence with Bradley, astronomer royal of England, in the middle of the last century. Although the general principles by which the telescope could be used for the accurate measurement of angles were understood by the English and French astronomers before the end of the seventeenth century, yet the instruments were so rude in construction, and the principles underlying their use so little understood, that the observations made with them were little better than a skilled astronomer of the present time might learn to make without telescopic aid. The forward step made by English mechanicians in the construction of instruments, and by Bradley in devising and using them, was quite comparable in importance with the telescope itself.

No improvement was made on Bradley's work until the rise of the German school of practical astronomy, more than half a century later. With Bessel and Struve, the twin founders of this school, astronomical instruments became the material embodiments of geometrical conceptions, to be investigated by rigorous methods. The astronomy of precision to-day owes its perfection to the continuous development of their ideas.

Among the foremost of the living men who have continued the work of Bessel and Struve must be placed Dr. Auwers; less, however, in the direction of investigating instruments and the principles of their construction than of discussing observations made with them. His inaugural dissertation for the degree of Doctor of Philosophy, which appeared at Königsberg in 1862, struck the keynote of his life work. It comprised an investigation of the variable proper motions of Sirius and Procyon, on the supposition that each of them was attracted by an invisible satellite.

In 1844 Bessel had shown in an elaborate paper that the proper motions of Sirius and Procyon formed an exception to what was the rule in the case of all other fixed stars, which move uniformly and in a straight line. He concluded with the remark that the observations seemed to show an inequality with a period of about half a century; but, with that caution in stating even hypothetical conclusions which is a mark of the best science of our time, he made no hypothesis respecting the cause of the inequality, although he must have entertained the suspicion that it was due to a satellite.

A few years later, Peters made a yet more thorough investigation of the proper motion of Sirius, and showed that it could be represented by supposing that an invisible satellite revolved around it, in a period of fifty years.

Dr. Auwers's work comprises a detailed and profound investigation of all the original observations which could aid in determining the law of the inequality and the elements of the orbit of the satellite which produced it. The observations of every observatory in the world, which could add to the weight of the results, were investigated in detail, and the conclusion finally reached that Procyon revolved around an invisible center in a period of forty years, in an apparently circular orbit, and at a distance of 1.05 minutes.

A similar investigation of the motion of Sirius was not finally published until 1868, after the discovery of the companion by our countryman, Mr. Alvan Clark. Auwers's investigation of the orbit was carried through, without reference to the observations of this companion, which, in fact, could then serve no purpose other than to indicate the direction of the center of motion at the time. It was found that the orbit, instead of being apparently circular, like that of Procyon, was really very eccentric, and rendered yet more so by being seen obliquely from our solar system. Among the interesting results of the work was

an ephemeris showing the apparent course of the satellite during a complete revolution, which took place in forty-nine years. It was thus found, that the satellite might be expected to attain a maximum distance in about 1870, and then to approach again until 1891, when it would be distant from the primary only 2.3 minutes, and therefore be entirely invisible in the most powerful telescope. The precision of the results could thus be tested year by year as observations were continued. It was soon found that the actual motion of the satellite was more rapid than its predicted motion, and the orbit more nearly circular, the variation of the distance being slightly less than that given in the ephemeris.

From and after 1880, the distance was found to diminish, and in 1888, the satellite was seen for the last time, having disappeared in the rays of the primary in exact accord with Dr. Auwers's prediction. Whether it still eludes the keen eye of Burnham, combined with the great power of the Lick refractor, we have not certainly learned; but even if it does, we may confidently look for its reappearance in a very few years.

The next considerable work of Dr. Auwers in sidereal astronomy was his determination of a fundamental system of declinations to which all catalogues of stars should be reduced. It had long been known that important discordances existed among the declinations of the best catalogues, which could not be accounted for by ordinary instrumental errors, the causes of which are even now obscure. The object of Dr. Auwers's work was to obtain a general mean from all the best catalogues, and construct tables for reducing each separate one to this mean.

Another subject to which Auwers has devoted especial attention is that of the parallaxes of the fixed stars. His paper on the determinations of stellar parallax with the Königsberg heliometer contains a very exhaustive investigation of the celebrated instrument with which Bessel determined the parallax of 61 Cygni. One result of this investigation is, that the parallax of 61 Cygni is 0.55″, while Bessel had found it to be one-third of a second. He also made at Gotha a determination of the parallax of 34 Groombridge, which he deduced as 0.307″.

Passing over a number of minor works, covering almost every department of exact astronomy, we now come to his greatest and recently completed work, the reduction anew of Bradley's observations. It is remarkable that these observations, which form an epoch in the history of exact astronomy, long remained unpublished, owing to a legal question respecting their ownership. They were at length reduced by Bessel, and the general results published in his celebrated Fundamenta Astronomiæ. The title of this work shows the importance he attributed to Bradley's observations, which has been so much neglected in the country where they were made. Bessel's work, however, left much to to be desired, owing not only to the period when it was made, but to the lack of time to make the necessarily detailed and exhaustive investigation, and the lack of knowledge of the requisite constants of reduc-

tion. Auwers repeated the work with an exhaustiveness and thoroughness which makes it at once a masterpiece and a model. No details are too minute for his attention, and no point is unworthy of discussion which would add to the accuracy of the results. It is to consist of three large volumes, two of which are already published, the third being still in press.

Dr. Auwers has also rendered important services to the science of astronomy in an administrative capacity. As chairman of the Zone Commission of the Astronomische Gesellschaft, he took an active part in planning and directing the great work, now approaching completion, of constructing an accurate catalogue of all the stars of the northern hemisphere down to the ninth magnitude, by the combined labors of a number of the leading observatories of the world.

This work is a continuation of that of Argelander and Schönfeld, to the latter of whom the Academy awarded the Watson medal two years ago. What Argelander and Schönfeld did, was to prepare a complete catalogue of the stars of the northern hemisphere to nearly the tenth magnitude. The total number of stars included in Argelander's alone was more than 300,000. In this preliminary catalogue the positions of the stars could be determined only with sufficient approximation to serve for their identification and use in observation. The labor involved in the final determination of accurate positions is such that even now, after the lapse of more than twenty years, the work is still incomplete.

As chairman of the Commission having the direction of the work, Dr. Auwers has taken a leading part in superintending its execution, while, at the Berlin observatory, he also acted as one of the observers on the Zone assigned to that institution.

As chairman of the German Commission on the Transit of Venus, Dr. Auwers has had the superintendence of the reductions and printing made under the direction of the German Government. Three stately volumes bear evidence of the skill and zeal with which he has executed this office.

This brief enumeration of the principal works of Auwers does not exhaust his claims upon our consideration. We present his name to the Academy, not merely as that of an astronomer who has been the author of many important works, but as a worthy representative of the best astronomy of our time.

S. NEWCOMB.
B. A. GOULD.
A. HALL.

WASHINGTON, *April, 1891.*

REPORT OF THE AUDITING COMMITTEE.

The following report of the auditing committee was presented to the Academy, and, on motion of Mr. Remsen, was accepted:

WASHINGTON, D. C., *April 21, 1891.*

To the President of the National Academy of Sciences:

SIR: The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances correspond to the vouchers, books, and accounts of the treasurer, and are found correct.

LEWIS BOSS.
F. W. PUTNAM.
G. W. HILL.

TREASURER'S REPORT.

APRIL 21, 1891.

To the President of the National Academy of Sciences:

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 21, 1891:

1. General account, April 15, 1890, to April 21, 1891.

Receipts:	
Balance brought forward from April 15, 1890	$453.36
Amount of invested income	*500.00
Income received during the year	473.26
Total to be accounted for	1,426.62
Disbursements:	
Disbursed during the year	529.12
Balance on hand	397.50
Invested income on hand	*500.00
Actual balance after deducting outstanding obligations	897.50

2. The Bache trust fund.

Receipts:	
Balance brought forward from April 15, 1890	$4,533.69
Reimbursement	3.00
Income received during the year	2,489.72
Total to be accounted for	7,026.41
Disbursements:	
Disbursed during the year	2,806.17
Balance on hand	4,220.24
Actual balance after deducting outstanding obligations	417.91

* Invested in District of Columbia 3.65 bonds.

3. The Watson trust fund.

Receipts:	
Balance brought forward from April 15, 1890	$915.96
Amount of invested income	*1,500.00
Income received during the year	986.75
Total to be accounted for	3,432.71
Disbursements:	
Disbursed during the year	553.48
Balance on hand	1,379.23
Invested income on hand	*1,500.00
Transfer to investment fund	8.33
Actual balance after deducting outstanding obligations	2,887.56

There still remains in the bank, uninvested, $37.80.

4. The Henry Draper medal fund.

Receipts:	
Balance brought forward from April 15, 1890	$443.95
Income received during the year	330.19
Total to be accounted for	774.14
Disbursements:	
Disbursed during the year	25.72
Balance on hand	748.42

5. The J. Lawrence Smith medal fund.

Receipts:	
Balance brought forward from April 15, 1890	$937.00
Income received during the year	411.75
Total to be accounted for	1,348.75

Very respectfully,

J. S. BILLINGS,
Treasurer, National Academy of Sciences.

REPORT OF THE COMMITTEE ON SECURITIES HELD BY THE ACADEMY.

The committee, Messrs. Gill and White, appointed to verify the securities held by the Academy, presented the following report, which was approved:

1. General fund.

District of Columbia 3.65 bonds	$500.00

2. Bache trust fund.

United States 4 per cent. bonds, registered	$3,850.00
Philadelphia 6 per cent. bonds, registered	600.00
	4,450.00

Deed of 160 acres of Missouri lands to A. D. Bache, not yet transferred to the name of the Academy.

* Invested in District of Columbia 3.65 bonds.

3. Joseph Henry fund.

An agreement with the Pennsylvania Company for insurance on lives and granting annuities, as to the final disposition of the Joseph Henry fund of $40,000.

4. Watson trust fund.

Certificate of stock of Michigan Mutual Life Insurance Company for 134 shares, par value $50 per share	$6,700.00
District of Columbia 3.65 bonds	1,500.00
Five Cosmos Club bonds, coupon, at $100 each	500.00
	8,700.00

5. Henry Draper medal fund.

Deed of trust of Mary Anna Palmer Draper, giving $6,000 to the Academy as a special fund.

6. J. Lawrence Smith medal fund.

Deed of trust of Mrs. Sarah Julia Smith, giving $8,000 to the Academy as a special fund.

In addition to the securities reported by the committee, the following notes are held by Riggs & Co., bankers, for collection for the Academy:

Walbridge loan: Three notes for $10,000 each, and one note for $5,000, payable May 20–23, 1892, interest at 5 per cent per annum, payable semi-annually	$35,000.00
Dubant loan: One note for $12,000, payable October 28–31, 1892, interest semi-annually, at 5 per cent	12,000.00
Redfern loan: Two notes for $6,000 each, payable November 29 and December 1, 1893, interest semi-annually, at 5 per cent	12,000.00
Hagner loan: One note for $9,000, payable July 15–18, 1894, interest semi-annually, at 5 per cent	9,000.00

INVITATIONS.

Mr. Langley invited the members of the Academy to an excursion down the river, to Marshall Hall, on Thursday afternoon, April 23. As this invitation was accepted by the Academy, no public session was held that afternoon, the home secretary having given the requisite notice to that effect.

A letter was received from the secretary of the Cosmos Club, extending the privileges of the club to members of the Academy during the meeting in Washington.

Mr. Gould, on behalf of the National Geographic Society, invited the members of the Academy to attend a lecture Friday evening, by H. M. Wilson, on the Geography and People of India.

The home secretary read an invitation from the Royal Society of Canada, requesting the Academy to send a delegate to its tenth annual meeting, to be held in Montreal, May 27, 1891.

The recommendations from the council, that this invitation be accepted, and that the president be authorized to appoint a delegate, were adopted by the Academy.

The president appointed Vice-President F. A. Walker to represent the Academy on this occasion.

NEW FOREIGN ASSOCIATES.

Messrs. J. S. Stas, of Brussels, and Carl Gegenbaur, of Heidelberg, were elected foreign associates of the Academy.

DEATH OF FOREIGN ASSOCIATE.

The president announced the death of a foreign associate, Gen. Don Carlos Ibañez, of Madrid, who died January 29, 1891.

The Academy then adjourned to meet in scientific session, in New York city, November 10, 1891.

SCIENTIFIC SESSION.

HELD IN NEW YORK CITY, NOVEMBER 10 TO 12, 1891.

A scientific session for the reading of papers only having been called by the council, as announced at the April meeting, the Academy met at Columbia College, New York city, November 10, 1891, and the meetings were continued on the 11th and 12th.

At the opening of this session President Low, of Columbia College, made an address of welcome to the Academy, and also announced that his predecessor, the late Dr. Barnard, a member of the Academy, had made provision in his will for a gold medal to be called the Barnard medal, and had requested the Academy to assume the duty of selecting persons worthy of this honor.

President Marsh returned thanks for the cordial welcome extended to the Academy by President Low, and for the admirable arrangements made for the meeting. He also said that the request to assume the proposed duties relating to the Barnard medal would be duly submitted to the Academy.

The following members were present during the session:

Abbe.	Chandler, S. C.	Langley.	Rood.
Abbot.	Cope.	Marsh.	Rowland.
Allen.	Gibbs, W.	Mayer.	Scudder.
Barker.	Gill.	Mendenhall.	Sellers.
Billings.	Gould.	Michelson.	Trowbridge, W. P.
Bowditch.	Hall, A.	Morse.	Verrill.
Brewer.	Hall, J.	Newton, H. A.	Walker.
Brooks.	Hastings.	Peirce.	Watson.
Brush.	Hunt.	Pickering.	Young.
Chandler, C. F.	Johnson.	Powell.	

The following papers were read and discussed:

1. GOODALE, G. L.: Some Aspects of Australian Vegetation. (Read by Mr. Scudder.)

2. GOODALE, G. L.: The Nomenclature of Vegetable Histology. (Read by Mr. Scudder.)

3. HASTINGS, C. S.: On Certain New Methods and Results in Optics. Discussed by Mr. Young.

4. MENDENHALL, T. C.: An Exhibition of the New Pendulum Apparatus of the U. S. Coast and Geodetic Survey, with some Results of its Use. Discussed by Messrs. Gould, Abbe, and Brewer.

5. MENDENHALL, T. C.: On the Use of a Free Pendulum as a Time Standard.

6. COPE, E. D.: On Degenerate Types of Scapula and Pelvic Arches in the Lacertilia. Discussed by Messrs. Morse and Brewer.

7. OSBORNE, T. B.: presented by S. W. Johnson: The Proteids or Albuminoids of the Oat Kernel. Second paper. (Read by Mr. Johnson.) Discussed by Mr. W. Gibbs.

8. PEIRCE, C. S.: Astronomical Methods of Determining the Curvature of Space. Discussed by Mr. Pickering.

9. ALLEN, J. A.: On Geographical Variation among North American Birds, considered in relation to the peculiar Intergradation of *Colaptes auratus and C. cafer*. Discussed by Messrs. Brewer, Morse, and Marsh.

10. CHANDLER, S. C.: On the Variation of Latitude. Discussed by Messrs. A. Hall, Gould, Pickering, and Young.

11. SCUDDER, S. H.: The Tertiary Rhynchitidæ of the United States. (Read by title.)

12. ROOD, O. N.: On a Color System. Discussed by Mr. Peirce.

13. REES, J. K.: presented by E. C. Pickering: Preliminary notice of the Reduction of Rutherfurd's Photographs. Discussed by Mr. Gould.

14. ROWLAND, H. A.: On the Application of Spectrum Analysis to the Analysis of the Rare Earths, and a New Method for the Preparation of Pure Yttrium. (Read by title.)

15. GILL, THEO.: A Nomenclator of the Families of Fishes. (Read by title.)

16. MICHELSON, A. A.: Measurement of Jupiter's Satellites by Interference. Discussed by Messrs. Chandler, Young, and Hall.

17. BROOKS, W. K.: The Follicle Cells of Salpa. Discussed by Mr. Morse.

DEATH OF MEMBERS.

At the close of the scientific session the president announced the death of the following members of the Academy who have died since the last meeting: Prof. John LeConte, Prof. Joseph Leidy, Prof. Julius E. Hilgard, and Prof. William Ferrel.

The following members were appointed to prepare the biographical memoirs:

On Prof. LeConte, Prof. Joseph LeConte.
On Prof. Leidy, Dr. S. Weir Mitchell.
On Prof. Hilgard, Prof. E. W. Hilgard.
On Prof. Ferrel, Prof. Cleveland Abbe.

The Academy then adjourned to meet in Washington the third Tuesday in April, 1892.

SPECIAL SESSION.

IN THE NEW YORK CITY, NOVEMBER 11, 1891.

A special session of the Academy having been called by the council, in accordance with Article III, section 1, of the constitution, the Academy convened at Columbia College, New York City, November 11, 1891, the president, Prof. O. C. Marsh, presiding.

The president stated that his annual report to Congress, as far as completed, and the recommendations from the council that he should include

in this report the proceedings of the present meeting was adopted by the Academy.

TREASURER'S STATEMENT.

A statement from the treasurer, Dr. J. S. Billings, dated November 9, 1891, and showing the following available balances, was read by the home secretary:

General fund	$715.98
Bache fund	502.77
Watson fund	3,111.60
Draper fund	913.51
Smith fund	1,551.62

The home secretary also read letters from the treasurer relating to a portion of the funds of the Watson trust, and the following recommendation from the council was adopted by the Academy:

Resolved, That the treasurer, Dr. John S. Billings, is authorized to sell the 134 shares of stock of the Michigan Mutual Life Insurance Co. now held in the name of the Academy, for the price named in the offer of Mr. Dusenbury in his letter of the 9th inst., viz, 160 and accrued interest to date; and to invest the proceeds of this sale as proposed by the treasurer in his letter of the 9th inst.

In regard to the memoirs of the Academy, the home secretary reported that one hundred pages of volume v had been printed, but that some delay had been caused by the illustrations. This difficulty was now removed and the printing would soon be resumed.

THE BARNARD MEDAL.

The following documents from the trustees of Columbia College, concerning the proposed Barnard medal, were then read by the home secretary:

THE TRUSTEES OF COLUMBIA COLLEGE
IN THE CITY OF NEW YORK, NO. 67 WALL STREET.
New York, November 7, 1891.

GENTLEMEN: The trustees of Columbia College, as residuary legatees and devisees of the late President Barnard, have accepted and undertaken to perform the trusts created by his will and have instructed me to communicate with you for the purpose of ascertaining your willingness to charge yourselves with the duty of declaring to the trustees of Columbia College at the close of every term of five years the name of the person whom you judge worthy to receive the "Barnard Medal for Meritorious Service to Science."

I inclose herewith a copy of the portion of President Barnard's will relating to the medal referred to, together with a transcript from the minutes of the trustees.

Very respectfully,

JOHN B. PINE,
Clerk.

THE NATIONAL ACADEMY OF SCIENCES.

EXTRACT FROM THE WILL OF F. A. P. BARNARD.

2. All the remainder of my property invested as aforesaid to constitute a fund, under the name of the Barnard Fund for the Increase of the Library; the income from the same to be devoted to the purchase on account of the library of Columbia College

of such books as from time to time may be most needed, but especially relating to physical or astronomical science; selecting, in preference, those which may be likely to be most useful to persons engaged in scientific investigation. But of the income from this said fund I desire that so much as may be necessary shall be applied in the manner following: The trustees of Columbia College shall cause to be struck with suitable devices, a medal of gold, nine-tenths fine, of the bullion value of not less than two hundred dollars, to be styled "The Barnard Medal for Meritorious Service to Science;" and shall publicly announce that a copy of the same shall be awarded, at the close of every quinquennial period, dating from the probate of this my last will and testament, to such person, whether a citizen of the United States or of any other country, as shall, within the five years next preceding, have made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as, in the judgment of the National Academy of Sciences of the United States, shall be esteemed most worthy of such honor. And I make it my request that the said National Academy of Sciences shall charge itself with the duty of declaring to the trustees of Columbia College, aforesaid, at the close of every term of five years, as above defined, the name of the person whom they judge worthy to receive such medal, with a statement of the reasons on which their judgment is founded; and that, upon such declaration and nomination, the trustees shall proceed to award the said medal, and shall transmit the same to the person entitled to receive it, accompanied by a diploma or certificate attesting the fact and the occasion of the award. But, if the said National Academy of Sciences shall judge that, during the five years preceding the date at which, as above provided, this award shall become due no discovery in physical or astronomical science, or no new application of scientific principles to useful purposes, has been made worthy of the distinction proposed, then it is my wish and request the award shall be for that time omitted. And I would further desire that the medal above described should bear, if it can be accomplished without interfering with the appropriate artistic devices, upon its obverse side the motto, *Magna est Veritas*, and upon its reverse the motto, *Deo optimo Maximo, Gloria in Excelsis*.

EXTRACT FROM THE MINUTES OF THE MEETING OF THE TRUSTEES OF COLUMBIA COLLEGE.

At a meeting of the trustees of Columbia College in the city of New York, held at the college on Monday, the 2d day of November, in the year of our Lord one thousand eight hundred and ninety-one, the following action was taken:

Resolved, That the trustees accept with grateful appreciation the gifts of the late President Barnard, and undertake and agree to perform the trusts created by the will.

Resolved, That the remainder of the property bequeathed to the college by Dr. Barnard be set apart as a fund to be known as the "Barnard Fund for the Increase of the Library;" that so much of the income of said fund as may be necessary be applied to the manufacture and supply once in every five years of a gold medal of the bullion value of not less than $200, to be known as "The Barnard Medal for Meritorious Service to Science;" and that the remainder of the income of the said fund be applied to the purchase for the library of such books as from time to time may be most needed but especially relating to physical or astronomical science, selecting in preference those which may be likely to be most useful to persons engaged in scientific investigation.

Resolved, That it be referred to the committee on the library to cause to be prepared and to submit a suitable design for such medal, the design conforming as nearly as practicable to the suggestions contained in the will.

Resolved, That one such medal be awarded at commencement at the close of every quinquennial period, dating from the 17th day of July, 1889, to such person, if any, whether a citizen of the United States or of any other country, as shall, within the

five years next preceding have made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as in the judgment of the National Academy of Sciences of the United States shall be esteemed most worthy of such honor.

Resolved, That the Clerk be instructed to transmit to the National Academy of Sciences a copy of that portion of the will of Dr. Barnard relating to "The Barnard Medal for Meritorious Service to Science" and to ascertain whether such Academy will charge itself with the duty of declaring to the trustees at the close of every term of five years, the name of the person whom they judge worthy to receive such medal.

A true copy.

JOHN B. PINE,
Clerk.

RECOMMENDATIONS FROM THE COUNCIL.

The following recommendations from the council were then read by the home secretary, and were adopted by the Academy:

1. That the Academy accept the trust relating to the medal provided by the will of Dr. F. A. P. Barnard.

2. That a committee of five members be appointed to nominate to the Academy from time to time the name of the person to be designated as the recipient of the Barnard medal.

COMMITTEE ON THE BARNARD MEDAL.

The following members were appointed by the president as this committee:

C. F. Chandler, chairman; Lewis Boss, J. P. Cooke, E. S. Dana, G. Brown Goode.

NOMINATIONS.

Four nominations for membership in the Academy were read by the home secretary. These will be acted upon at the next meeting, in April, 1892.

The special session then adjourned.

Respectfully submitted.

O. C. MARSH,
President of the National Academy of Sciences.

APPENDICES.

APPENDIX A.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. H. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. LeConte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Peirce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own

organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March three, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June* 10, 1882.

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June* 24, 1884.

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

APPENDIX B.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875, April 21, 1881, April 19, 1882, April 18, 1883, and April 19, 1888.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States, on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I. OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution of the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council, shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its session next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those of the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special meetings may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election for officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected, and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he received two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president, and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be, at all times, at the disposition of the Government, upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation, submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States; or, with the approval of the council, in State bonds, or first mortgage bonds, or real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receives two-thirds of the votes cast, it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the member were present.

RULES.

I. In the absence of any officer, a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected by a plurality of members present to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented, which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year, and referred with the accounts to the auditing committee.

IV. A committee of arrangements consisting of five members shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members; to arrange the business of each day; to receive the titles of papers, reports, etc.; and to arrange the order of reading, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to fix the length of time to be devoted to reading of all papers submitted, and to limit the time to be occupied in their discussion.

V. At the meetings, the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.
8. On the last days of the session, the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings shall be convened at noon.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session. But no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date in the records of the Academy from the date of their presentation to the Academy, and the order of their presenta-

tion shall be that in which they were registered, unless changed by consent of the author.

XI. Papers from persons not members, read before the Academy, and intended for publication, shall be referred, at the meeting at which they are read, to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. An annual of the Academy shall be prepared and published by the secretaries.

XIII. The printing of the Academy shall be under the charge of a committee of publication, to consist of the home secretary and four other members to be named by the president, with the advice and consent of the council.

XIV. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XVI. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVII. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVIII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of departments of the Government, and in each case to look to the department requesting the investigation for reimbursement to the Academy.

XIX. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XX. At least sixty days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of the list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XXI. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXII. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXIII. Any rule of the Academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, *ex officio*, a member of all Government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1891.

	Expiration of term.
MARSH, O. C., *President*	April, 1895
WALKER, F. A., *Vice-President*	April, 1897
GIBBS, WOLCOTT, *Foreign Secretary*	April, 1892
HALL, A., *Home Secretary*	April, 1895
BILLINGS, JOHN S., *Treasurer*	April, 1893

ADDITIONAL MEMBERS OF COUNCIL, 1890–'91.

BRUSH, G. J.
GOULD, B. A.
LANGLEY, S. P.
MEIGS, M. C.
NEWCOMB, S.
REMSEN, IRA.

COMMITTEES OF THE ACADEMY.

On Ways and Means to Provide a Fund for the Academy.

ROGERS, FAIRMAN, *Chairman.*
CHANDLER, C. F.
MARSH, O. C.
MITCHELL, S. WEIR.
PUMPELLY, R.

On Weights, Measures, and Coinage.

GIBBS, WOLCOTT.
GOULD, B. A.
MEIGS, M. C.
NEWCOMB, S.
NEWTON, H. A.
PEIRCE, C. S.
TROWBRIDGE, W. P.

On the Election of Foreign Associates.

GIBBS, WOLCOTT, *Chairman.*
DANA, J. D.
GOULD, B. A.
HALL, A.
NEWCOMB, S.

On Reserving Public Lands on and near Mount Whitney, California, for Scientific Purposes.

LANGLEY, S. P., *Chairman.*
BREWER, W. H.
POWELL, J. W.

On Publication.

THE HOME SECRETARY.
BILLINGS, J. S.
MENDENHALL, T. C.
NEWCOMB, S.
POWELL, J. W.

On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.
BILLINGS, J. S.
BRUSH, G. J.
MEIGS, M. C.
POWELL, J. W.

On Investigation of the North Magnetic Pole.

LANGLEY, S. P., *Chairman.*
ABBOT, H. L.
TROWBRIDGE, W. P.
MAYER, A. M.
SCHOTT, C. A.
TROWBRIDGE, J.
CARPMAEL, C.

On Uniformity of Measures in Physical Apparatus.

LANGLEY, S. P., *Chairman.*
MENDENHALL, T. C.
PICKERING, E. C.

TRUST FUNDS.

Board of Direction of the Bache Fund.

GIBBS, W., *Chairman.*
DANA, J. D.
GOULD, B. A.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.*
GOULD, B. A.
HALL, A.

The Henry Draper Fund.

BARKER, G. F., *Chairman.*
GIBBS, W.
NEWCOMB, S.
WRIGHT, A. W.
YOUNG, C. A.

The J. Lawrence Smith Fund.

GIBBS, WOLCOTT, *Chairman.*
BRUSH, G. J.
HALL, A.
PUMPELLY, R.
RUTHERFURD, L. M.

The Barnard Medal.

CHANDLER, C. F., *Chairman.*
BOSS, LEWIS.
COOKE, J. P.
DANA, E. S.
GOODE, G. BROWN.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY, 1892.

		Date of election.
ABBE, CLEVELAND	*Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*Army Building, New York City.*	1872
ALLEN, J., ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	*3909 Locust St., Philadelphia, Pa.*	1876
BARTLETT, WILLIAM H. C	*75 Locust Hill Ave., Yonkers, N. Y.*	——
BELL, A. GRAHAM	*Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*Washington, D. C.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BROWN-SEQUARD, CHARLES E	*Paris, France.*	1868
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CASEY, THOMAS L., U. S. A	*Washington, D. C.*	1890
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	*16 Craigie St., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*Army Building, New York City.*	1884
COOKE, JOSIAH P	*Cambridge, Mass.*	1872
COPE, EDWARD D	*2100 Pine St., Philadelphia, Pa.*	1872
COUES, ELLIOTT	*Washington, D. C.*	1877
CRAFTS, JAMES M	*59 Marlborough St., Boston, Mass.*	1872
DANA, EDWARD S	*New Haven, Conn.*	1884
DANA, JAMES D	*New Haven, Conn.*	——
DAVIDSON, GEORGE	*San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Washington, D. C.*	1884
FARLOW, W. G	*Cambridge, Mass.*	1879
GENTH, FREDERICK A	*W. Philadelphia, Pa.*	1872
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
GOODE, G. BROWN	*Washington, D. C.*	1888
GOULD, BENJAMIN A	*Cambridge, Mass.*	——
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH, U. S. N	*Washington, D. C.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*Washington, D. C.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*San José, California.*	1885
HUNT, T. STERRY	*New York City.*	1873
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*New Haven, Conn.*	1866
KING, CLARENCE	*Century Club, New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LESLEY, J. PETER	*1008 Clinton St., Philadelphia, Pa.*	——
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LOVERING, JOSEPH	*Cambridge, Mass.*	1873
MARSH, O. C	*New Haven, Conn.*	1874
MAYER, ALFRED M	*Hoboken, N. J.*	1872
MAYO-SMITH, RICHMOND	*Columbia College, New York City.*	1890
MEIGS, MONTGOMERY C., U. S. A	*Washington, D. C.*	1865
MENDENHALL, THOMAS C	*Washington, D. C.*	1887
MICHAEL, ARTHUR	*Somerville, Mass.*	1889
MICHELSON, ALBERT A	*Worcester, Mass.*	1888
MITCHELL, HENRY	*Boston, Mass.*	1885
MITCHELL, S. WEIR	*1524 Walnut St., Philadelphia, Pa.*	1865
MORSE, EDWARD S	*Salem, Mass.*	1876

		Date of election.
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWBERRY, J. S	*New York City.*	——
NEWCOMB, SIMON, U. S. N	*Washington, D. C.*	1869
NEWTON, H. A	*New Haven, Conn.*	——
NEWTON, JOHN, U. S. A	*New York City.*	1876
OLIVER, JAMES E	*Ithaca, N. Y.*	1872
PACKARD, A. S	*Providence, R. I.*	1872
PIERCE, CHARLES S	*U. S. Coast Survey, Washington, D. C.*	1877
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs Ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	*147 S. Fourth St., Philadelphia, Pa.*	——
ROGERS, WILLIAM A	*Waterville, Me.*	1885
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
RUTHERFURD, LEWIS M	*175 Second Ave., New York City.*	——
SCHOTT, CHARLES A	*Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	*1600 Hamilton St., Philadelphia, Pa.*	1873
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
TROWBRIDGE, WILLIAM P	*New York City*	1872
TRUMBULL, J. H	*Hartford, Conn.*	1872
VERRILL, A. E	*New Haven, Conn.*	1872
WALKER, FRANCIS A	*Boston, Mass.*	1878
WATSON, SERENO	*Cambridge, Mass.*	1889
WHITE, CHARLES A	*Washington, D. C.*	1889
WOOD, HORATIO C	*1925 Chestnut St., Philadelphia, Pa.*	1879
WRIGHT, ARTHUR W	*New Haven, Conn.*	1891
YOUNG, CHARLES A	*Princeton, N. J.*	1872

HONORARY MEMBERS.

AGASSIZ, ALEXANDER	*Cambridge, Mass.*
LONGSTRETH, MIERS F	*Derby, Pa.*
LYMAN, THEODORE	*Brookline, Mass.*

DECEASED MEMBERS.

	Date of death.
*AGASSIZ, LOUIS	Dec. 14, 1873
*ALEXANDER, J. H	Mar. 2, 1867
*ALEXANDER, STEPHEN	June 25, 1883
*BACHE, ALEXANDER DALLAS	Feb. 14, 1867
*BAIRD, SPENCER F	Aug. 19, 1887
BARNARD, J. G	May 14, 1882
BARNARD, F. A. P	Apr. 27, 1889
*CASWELL, ALEXIS	Jan. 8, 1887
*CHAUVENET, WILLIAM	Dec. 13, 1870
CLARK, HENRY JAMES	July 1, 1873
COFFIN, JAMES H	Jan. 6, 1873
COFFIN, J. H. C	Jan. 8, 1890
COOK, GEORGE H	Sept. 22, 1889
*DALTON, J. C	Feb. 2, 1889
DAVIS, CHARLES H	Feb. 18, 1877
*DRAPER, HENRY	Nov. 20, 1882
*DRAPER, JOHN W	Jan. 4, 1882
*EADS, JAMES B	Mar. 8, 1887
ENGELMANN, GEORGE	Feb. 11, 1884
FERREL, WILLIAM	Sept. 18, 1891
*FRAZER, JOHN FRIES	Oct. 12, 1872

*Biographical notices have been presented of those designated by a *.

	Date of death.
*GABB, WILLIAM M	May 30, 1878
GILLISS, JAMES MELVILLE	Feb. 9, 1865
*GOULD, AUGUSTUS A	Sept. 15, 1866
*GRAY, ASA	Jan. 30, 1888
*GUYOT, ARNOLD	Feb. 8, 1884
*HADLEY, JAMES	Aug. 1, 1864
*HALDEMAN, S. S	Sept. 10, 1880
HAYDEN, F. V	Dec. 22, 1887
*HENRY, JOSEPH	May 13, 1878
HILGARD, JULIUS E	May 8, 1891
*HITCHCOCK, EDWARD	Feb. 27, 1864
*HOLBROOK, J. E	Sept. 8, 1871
*HUBBARD, J. S	Aug. 16, 1863
*HUMPHREYS, A. A	Nov. 28, 1883
*KIRTLAND, JARED P	Dec. 10, 1877
*LANE, J. HOMER	——, 1880
LE CONTE, JOHN	Apr. 29, 1891
*LE CONTE, JOHN L	Nov. 15, 1883
LEIDY, JOSEPH	Apr. 30, 1891
*LESQUEREUX, LEO	Oct. 25, 1889
*LOOMIS, ELIAS	Aug. 16, 1889
*MAHAN, D. H	Sept. 16, 1871
*MARSH, G. P	July 23, 1882
*MEEK, F. B	Dec. 21, 1877
*MORGAN, LEWIS H	Dec. 14, 1881
*NORTON, WILLIAM A	Sept. 21, 1883
PETERS, C. H. F	July 18, 1890
*POURTALES, L. F	July 17, 1880
RODGERS, JOHN	May 5, 1882
ROGERS, ROBERT E	Sept. 7, 1881
*ROGERS, WILLIAM B	May 30, 1888
*SAXTON, JOSEPH	Oct. 26, 1873
*SILLIMAN, BENJ., Sr	Nov. 24, 1864
SILLIMAN, BENJ., Jr	Jan. 14, 1885
*SMITH, J. LAWRENCE	Oct. 12, 1883
*STIMPSON, WILLIAM	May 26, 1873
*STRONG, THEODORE	Feb. 1, 1869
*SULLIVANT, W. S	Apr. 30, 1873
*TORREY, JOHN	Mar. 10, 1873
*TOTTEN, J. G	Apr. 22, 1864
*TUCKERMAN, EDWARD	Mar. 15, 1886
*WARREN, G. K	Aug. 8, 1882
*WATSON, JAMES C	Nov. 23, 1880
*WINLOCK, JOSEPH	Jan. 11, 1875
*WOODWARD, J. J., U. S. A	Aug. 17, 1884
WORTHEN, A. H	May 6, 1888
*WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

BUNSEN, ROBERT W	*Heidelberg.*
AIRY, SIR GEORGE B	*Greenwich.*
OWEN, SIR RICHARD	*London.*
BURMEISTER, C. H. C	*Buenos Ayres.*
STRUVE, OTTO VON	*Pulkova.*
ADAMS, J. C	*Cambridge.*
CAYLEY, ARTHUR	*Cambridge.*
HELMHOLTZ, BARON H. VON	*Berlin.*
PASTEUR, LOUIS	*Paris.*
STOKES, SIR GEORGE G	*Cambridge.*
SYLVESTER, J. J	*Oxford.*
HOOKER, SIR J. D	*Kew.*
THOMPSON, SIR WILLIAM	*Glasgow.*
AUWERS, ARTHUR	*Berlin.*

* Biographical notices have been presented of those designated by a *.

BERTRAND, J. L. F.....*Paris.*
HUXLEY, T. H.....*London.*
VIRCHOW, RUDOLPH VON.....*Berlin.*
BERTHELOT, M. P. E.....*Paris.*
DE CANDOLLE, ALPHONSE.....*Geneva.*
KÖLLIKER, ALBERT VON.....*Würzburg.*
RICHTHOFEN, F. VON.....*Berlin.*
HOFFMAN, A. W.....*Berlin.*
STAS, JEAN SERVAIS.....*Brussels.*
GEGENBAUR, KARL.....*Heidelberg.*

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILMON.
CARL ERNST VON BAER.
HENRY MILNE-EDWARDS.
MICHAEL FARADAY.
L. ELIE DE BEAUMONT.
SIR DAVID BREWSTER.
G. A. A. PLANA.
F. W. A. ARGELANDER.
FRIEDRICH WÖHLER.
J. B. DUMAS.
J. B. J. D. BOUSSINGAULT.
M. E. CHEVREUL.
MICHEL CHASLES.
SIR RODERICK I. MURCHISON.
VICTOR REGNAULT.
H. W. DOVE.
C. A. F. PETERS.
JUSTUS VON LIEBIG.
ALEXANDER BRAUN.
JOACHIM BARRANDE.
ADOLPHE WÜRTZ.
THEODORE VON OPPOLZER.
G. R. KIRCHOFF.
RUDOLPH CLAUSIUS.
JAMES P. JOULE.
CARLOS IBAÑEZ

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1892.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1893.

LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 10, 1893.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences during the past year.

Very respectfully,

O. C. MARSH,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

The National Academy of Sciences was established by act of Congress in March, 1863, with power to frame its own constitution, select its own members, and provide in other respects for its continuance and successful operation.

The object of the Academy is to advance science, and especially to investigate, examine, experiment, and report on any subject of science or art whenever called upon by any department of the Government.

The Academy contains at present about one hundred members, and these have all been selected for their original researches in science. They represent within their ranks nearly every department of knowledge, and their services, in accordance with the charter of the Academy, are always at the disposal of the Government without compensation.

SESSIONS OF THE NATIONAL ACADEMY.

During the past year the Academy has held three sessions. The first was the regular annual meeting, held in Washington, D. C., April 19 to 22, 1892; the second was a scientific session, in Baltimore, Md., November 1 to 3, 1892; and the third was a special meeting in Baltimore, November 2, 1892.

STATED SESSION.

[Held in Washington City, April 19 to 22, 1892.]

The Washington session was held in the National Museum, the president, Prof. O. C. Marsh, presiding.

The following members were present during the session:

Abbe,	Comstock,	Hall, J.,	Pumpelly,
Abbot,	Cope,	Hill, G. W.,	Putnam,
Barker,	Coues,	King,	Remsen,
Billings,	Dana, E. S.,	Langley,	Rowland,
Boss,	Gibbs, W.,	Marsh,	Schott,
Brewer,	Gilbert,	Mayer,	Walker,
Brush,	Gill,	Mendenhall,	White,
Casey,	Gould,	Morse,	Young.
Chandler, S. C.,	Hague,	Powell,	
Chittenden,	Hall, A.,		

During this session, the following papers were read and discussed:

(1) Gilbert, G. K.: An American Maar. Discussed by Messrs. Abbe and Gilbert.

(2) Woodward, R. S., presented by T. C. Mendenhall: The Form and Efficiency of the Iced Bar Base Apparatus of the U. S. Coast and Geodetic Survey. Discussed by Messrs. Comstock and Woodward.

(3) Abbe, C.: On Atmospheric Radiation of Heat in Meteorology.

(4) Bigelow, F. H., presented by C. Abbe: On the Deflecting Forces that Produce the Diurnal Variation of the Normal Terrestrial Magnetic Field.

(5) Schott, C. A.: Abstract of Results from the U. S. Coast and Geodetic Survey Magnetic Observatory at Los Angeles, Cal., 1882-1889. Part III. Differential Measures of the Horizontal Component of the Magnetic Force. (Read by Mr. Mendenhall.) Discussed by Messrs. Abbe and Schott.

(6) Packard, A. S.: On the Anatomy and Systematic Position of the Mecoptera. (Read by Mr. Gill.)

(7) Chandler, S. C.: On the Laws of the Variation of Latitude. Discussed by Messrs. Boss, A. Hall, and S. C. Chandler.

(8) Chandler, S. C.: On the Causes of Variations of Period in the Variable Stars.

(9) Mendenhall, T. C.: On the Force of Gravity at Washington.

(10) Mendenhall, T. C.: On the Recent Variations of Latitude at Washington. Discussed by Messrs. A. Hall, Mendenhall, S. C. Chandler, Boss, Young, and Gould.

(11) Mayer, A. M.: On the Acoustic Properties of Aluminum, with Experimental Illustrations. Discussed by Messrs. Barker, S. C. Chandler, and Mayer.

(12) Lea, M. Carey: Disruption of the Silver Haloid Molecule by Mechanical Force. (Read by Mr. Barker.)

(13) Cope, E. D.: On the Homologies of the Cranial Arches of the Reptilia. Discussed by Messrs. Gill and Cope.

(14) Cope, E. D.: On the Osteology of the Genus Anniella. Discussed by Mr. Gill.

(15) Abbe, C.: The Astronomical, Geodetic, and Electric Consequences of Tidal Strains within an Elastic Terrestrial Spheroid.

(16) Morse, E. S.: Asiatic Influences in Europe. (Read by title.)

(17) Mayer, A. M.: Exhibition of Chladni's Acoustic Figures transferred to paper without distortion.

(18) Pupin, M. I., presented by T. C. Mendenhall: On Electrical Discharges through Poor Vacua, and on Coronoidal Discharges. Discussed by Mr. Abbe.

(19) Powell, J. W.: A Definition of Institutions. (Read by title.)

(20) Gill, T.: The Partition of the North American Realm. (Read by title.)

(21) Putnam, F. W.: Exhibition of Teeth of a Gigantic Bear, probably an extinct species, found in ancient mounds in Ohio.

(22) Lane, J. Homer: A Means of Measuring the Difference between the Tidal Change in the Direction of the Plumb Line and the Tidal Deflection of the Earth's Crust. (A posthumous paper, presented by C. Abbe.)

(23) Abbe, C.: Biographical Memoir of William Ferrel. (Read by title.)

(24) Abbe, C.: Biographical Memoir of J. Homer Lane. (Read by title.)

ELECTIONS.

The following members were elected for the council for the ensuing year: Messrs. Brush, Gould, Langley, Mendenhall, Newcomb, and Remsen.

THE WOLCOTT GIBBS FUND.

Mr. Gould stated that when Mr. Wolcott Gibbs reached the age of 70 years a number of his friends and pupils presented to him the sum of

$2,600 to establish a fund bearing his name, the income of which should be devoted to aiding in the prosecution of chemical research.

Mr. Gould then read the letter from Mr. Gibbs accepting this gift, and suggesting that the fund be intrusted to the Academy, and also prescribing the manner of applying it. The letter is as follows:

MY DEAR PROFESSORS JACKSON AND LOEB: May I beg you to present to those from whom I received, a few days since, so signal a mark of friendship and good-will my heartiest, most earnest, and most grateful acknowledgment? The address which I received on my seventieth birthday, signed by more than 100 friends, pupils, and assistants, brings back my youth in recalling the names of those who now join to offer me more than mere good wishes to cheer my advancing age. Their active friendship has taken the form which was most acceptable to me—that of an endowment to assist research in my own branch of science, so that I can feel that in a certain sense my power to work will not terminate with my life. As the generosity of my friends permits me also to dispose of the manner in which the endowment shall be administered, I submit to them, through you, the plan which seems to me best adapted to carry out their wishes—a plan which has been fully tested in somewhat similar cases and found to work well in practice.

I therefore propose that the fund raised for endowment shall be given to the National Academy of Sciences, to hold the same in trust, and to invest and reinvest as may be necessary or advisable. The income or interest of the fund shall be administered by a board of directors consisting of three persons, of whom at least two shall be members of the Academy. The first board shall consist of Charles Loring Jackson, Thomas M. Drown, and Ira Remsen, and the directors shall have power to fill vacancies in their own number, notifying the Academy of their action without delay. In case of the deaths of all the members of the board, their places shall be filled by persons holding professorships of chemistry, to be appointed by a vote of the Academy. The directors shall make an annual report to the Academy, stating the condition of the fund and the appropriations made during the year. They shall have absolute and entire control of the disposition of the income of the fund, employing it in such manner as they may deem for the best interest of chemical science.

It is my belief that the above, or a similar arrangement, is the best that can be made—that is to say, the one which is most likely to be of permanent benefit to science. I trust that it will meet with the approbation of those who have honored me with their confidence and their regard.

Sincerely yours,

WOLCOTT GIBBS.

NEWPORT, *March 1, 1892.*

The president in reply spoke of the honor shown the Academy by this mark of confidence. Mr. Brush moved that the matter be referred to the council to recommend such action as might be thought proper. This motion was adopted.

RECOMMENDATIONS FROM THE COUNCIL.

The following recommendations from the council were adopted by the Academy:

(1) That the Academy accept the charge of the Wolcott Gibbs fund for the promotion of chemical research, subject to the conditions expressed in Dr. Gibbs' letter to the donors; also that it offer its congratulations to Dr. Gibbs on the well-merited honor which has been conferred upon him, and its acknowledgments to him for the confidence which he has manifested by his disposal of the fund.

(2) That the boards of direction and trustees of the several trust funds of the Academy be authorized to sell, at their discretion, apparatus provided by them for special researches.

(3) That the membership fee for the ensuing year be $5.

REPORT OF THE AUDITING COMMITTEE.

The following report of the auditing committee was presented to the Academy, and, on motion of Mr. Gould, was accepted:

WASHINGTON, D. C., *April 19, 1892.*

The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances, correspond to the vouchers, books, and accounts of the treasurer, and are found correct.

THOMAS L. CASEY.
C. B. COMSTOCK.
R. H. CHITTENDEN.

TREASURER'S REPORT.

WASHINGTON, D. C., *April 19, 1892.*

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences, for the year ending April 19, 1892:

(1) General fund, April 21, 1891, to April 19, 1892.

Balance brought forward from April 21, 1891		$397.50
Amount of invested income		*500.00
Income received during the year		458.26
Total to be accounted for		1,355.76
Disbursed during the year	$355.16	
Balance on hand	500.60	
Invested income on hand	*500.00	
Total accounted for		1,355.76
Actual balance after deducting outstanding obligations		1,000.60

(2) The Bache trust fund.

Balance brought forward from April 21, 1891		$4,220.24
Appropriations reimbursed		1,212.50
Income received during the year		3,152.97
Total to be accounted for		8,585.71
Disbursed during the year	$4,560.63	
Balance on hand	4,025.08	
Total accounted for		8,585.71
Available balance after deducting outstanding obligations		1,674.29

* Invested in District of Columbia 3.65 per cent. bonds registered.

(3) The Watson trust fund.

Balance brought forward from April 21, 1891		$1,387.56
Amount of invested income		*1,500.00
Income received during the year		1,112.74
Total to be accounted for		4,000.30
Transferred to capital fund	$242.20	
Balance on hand	2,258.10	
Invested income on hand	*1,500.00	
Total accounted for		4,000.30
Available balance after deducting outstanding obligations		3,758.10

(4) The Draper medal fund.

Balance brought forward from April 21, 1891	$748.42
Income received during the year	330.19
Total to be accounted for	1,078.61
Balance on hand	1,078,61

(5) The Smith medal fund.

Balance brought forward from April 21, 1891	$1,348.85
Income received during the year	525.50
Total to be acounted for	1,874.25
Balance on hand	1,874.25

During the year, the following changes have occurred in the investments under the control of the National Academy of Sciences:

On the 14th of November, 1891, in accordance with special authority granted by the Academy, 134 shares of the Michigan Life Insurance Company, held for the Watson fund, were sold at 160, with interest, the proceeds amounting to $10,720, being an advance of $4,020 over the par value of the stock. This money, with the addition of $242.20 from the income of the Watson fund, was, in accordance with the advice and approval of the special committee on investments, invested in two loans on real estate in the city of Washington, at 5 per cent. interest, amounting to $11,000.

On the 9th of April, 1892, the Walbridge loan, amounting to $35,000, was paid with interest to May 20, 1892, being the date of the maturity of this loan, and the proceeds are still held as cash on hand uninvested.

The following is a statement of the present investments of the Academy, showing the proportion of each belonging to the different funds:

Bache fund.

United States 4 per cent. bonds, registered	$3,850.00	
Philadelphia 6 per cent. bonds, registered	600.00	
Dubant loan, 5 per cent	9,096.00	
Redfern loan, 5 per cent	9,096.00	
Hagner loan, 5 per cent	1,272.37	
Uninvested	26,530.00	
Total		$50,444.37

* Invested in District of Columbia 3.65 per cent. bonds, registered.

Watson fund.

Dubant loan, 5 per cent	$1,344.00	
Redfern loan, 5 per cent	1.344.00	
Hagner loan, 5 per cent	558.88	
Cosmos Club, 5 per cent	500.00	
Barber loan, 5 per cent	10,000.00	
Ginesi loan, 6 per cent	1,000.00	
Uninvested	3,920.00	
Total		$18,666.88

Draper fund.

Hagner loan, 5 per cent		6,603.75

Smith Fund.

Dubant loan, 5 per cent	1,560.00	
Redfern loan, 5 per cent	1,560.00	
Hagner loan, 5 per cent	565.00	
Uninvested	4,550.00	
Total		8,235.00
Total fund		83,950.00

Very respectfully,

JOHN S. BILLINGS,
Treasurer, National Academy of Sciences.

REPORT OF THE COMMITTEE ON SECURITIES HELD BY THE ACADEMY.

The committee appointed to verify the securities held by the Academy presented the following report, which was approved:

(*1*) *General fund.*

District of Columbia 3.65 per cent. bonds	$500.00

(*2*) *Bache trust fund.*

United States 4 per cent. bonds, registered	3,850.00
Philadelphia 6 per cent. bonds, registered	600.00
	4,450.00

Land warrant No. 62749 for 160 acres of land, S. E. quarter of section 11, township 34, range 23, Boonville, Mo. (This deed has not yet been transferred to the name of the Academy.)

(*3*) *Joseph Henry fund.*

An agreement with the Pennsylvania Company for insurance on lives and granting annuities, as to the final disposition of the Joseph Henry fund of $40,000. This will not be available until the decease of all Prof. Henry's children.

(*4*) *Watson trust fund.*

District of Columbia 3.65 per cent. bonds	$1,500.00
Cosmos Club bonds	500.00
	2,000.00

(5) Draper medal fund.

Deed of trust of Mary Anna Palmer Draper, giving $6,000 to the Academy as a special fund.

(6) Smith medal fund.

Deed of trust of Sarah Julia Smith, giving $8,000 to the Academy as a special fund.

The following papers were also found:

Certificate of Riggs & Co., bankers, that they hold on deposit for collection notes as follows:

Dubant loan: One note for $12,000, payable October 28–31, 1892; interest semiannually, at 5 per cent	$12,000
Redfern loan: Two notes for $6,000 each, payable November 29–December 1, 1893; interest semiannually, at 5 per cent	12,000
Hagner loan: One note for $9,000, payable July 15–18, 1894; interest semiannually, at 5 per cent	9,000
Barber loan: One note for $10,000, payable August 5, 1894; interest semiannually, at 5 per cent	10,000
Ginesi loan: One note for $1,000, payable January 2–5, 1897; interest semiannually, at 6 per cent	1,000

We certify that we have this day examined the securities and papers described above, and have found them to correspond to the preceding list.

G. K. GILBERT.
C. A. WHITE.

WASHINGTON, D. C., *April 12, 1893.*

REPORTS OF COMMITTEES.

On behalf of the committee on ways and means to provide a fund for the Academy, the president expressed regret that Mr. S. W. Mitchell, who had taken considerable pains to look after this matter, was not present at the meeting.

No report was received from the committee on weights, measures, and coinage. The president appointed Mr. Mendenhall to fill the place on this committee made vacant by the death of Mr. Meigs.

Mr. Gibbs, chairman of the committee on the election of foreign associates, presented a report recommending the election of the following gentlemen: Messrs. Hugo Gyldén, Stockholm; Carl Weierstrass, Berlin; E. Du Bois Reymond, Berlin; and August Kekulé, Bonn. The motion that the home secretary be authorized to cast the vote of the Academy for the gentlemen named was adopted, and they were declared elected.

Mr. Brewer, for the committee on reserving public lands on and near Mount Whitney, California, stated that there was no change from last year's report. The committee was continued.

For the committee on publication, Mr. Hall reported that Vol. V of the memoirs was nearly finished, and would probably be ready for distribution in about four weeks. There had been some delay in printing, but only about 20 pages remained to be put in type. The memoirs

for Vol. VI, Part 1, were at the Capitol, in the hands of the House committee.

Mr. Gill reported progress on the publications of the Academy.

In regard to the relations of the Academy to the Government, the president stated that no special relations now existed except as far as publications were concerned, and that everything was in good order.

No reports were submitted from the committees on the investigation of the north magnetic pole, and on uniformity of measures in physical apparatus.

For the board of direction of the Bache fund, Mr. Gibbs presented a brief report giving a statement of the appropriations made during the past year.

In behalf of the board of trustees of the Watson fund, Mr. Gould stated that no formal report had been prepared. The committee had continued the work of preparing tables of the asteroids discovered by the testator. The trustees had also awarded, with the approval of the Academy, an appropriation of $500 to Dr. S. C. Chandler to aid in his investigations regarding the variations of latitude.

Mr. Barker presented the following report from the trustees of the Henry Draper fund:

The committee on the Henry Draper fund unanimously recommend the award of the Henry Draper medal to Dr. H. C. Vogel, director of the astronomical observatory at Potsdam, for his spectroscopic observations upon the motion of stars in the line of sight, and kindred researches.

This report was approved by the Academy.

No report was submitted by the committee on the J. Lawrence Smith fund.

PROPOSITION FOR LIMITING MEMBERSHIP.

The home secretary read a letter to the president from Mr. Gould regarding a proposed limitation of the number of members of the Academy, which, if carried out, would be followed by a gift sufficient to afford an income of at least $1,500 per annum. The letter is as follows:

Prof. O. C. MARSH,

President, National Academy of Sciences.

DEAR SIR: A friend of the National Academy, who wishes to contribute to its welfare and influence, yet wishes that his name shall not be known, has the idea of making a large donation, sufficient to afford an income of at least $1,500 a year, for the purpose of defraying a portion of the expenses to which members are subjected in attending the meetings. He has given me his views freely, and wishes me to act as his organ of communication with the Academy, which I gladly do.

I believe that I fully comprehend his motives, which are of the highest, and now write to inform the Academy of his idea.

Being well acquainted with European academies of science, and hopeful that ours may follow a similar line of usefulness, he shares the feeling that there is danger of the number of our members being too large for the best attainment of the influence which the National Academy ought to exert in scientific affairs; believing that a

smaller number, even though above the original 50, would for many reasons be desirable, provided a larger proportion than in recent years could attend the meetings.

He is indisposed to encumber his gift with any conditions which might appear presumptuous, or to advise regulations which it is the province of the Academy itself to prescribe; yet a controlling element in his motives is that the gift may be a means of gradually reducing the number of members, in such a way as to insure a high standard in future elections, and at the same time increase the participation of members in the Academy's work.

I have naturally been giving a good deal of thought to the subject; and it seems to me that the end may be attainable without any violent change.

The losses which the Academy has recently suffered have reduced the number of its members to 90. Past experience shows that we ought to be prepared for an annual diminution of at least three, on the average. And as the scientific growth of the country seems not likely to offer, for some years to come, an equal number of persons who can be regarded as leaders in their respective sciences, the present time appears favorable for any action by the Academy, in the direction hoped for by the intending donor.

Various practical ways have suggested themselves for reducing the number of elections, without too stringent action. For instance, if it were provided that not more than two members should be elected annually, or if the minimum number of affirmative ballots requisite for an election were placed at 30 instead of 20, as now, or if the limit of members, above which four-fifths of the votes cast must be given for any candidate, were placed at 75 instead of 100, the desired end would probably be attained before the lapse of many years.

As to whether such action would be acceptable to the Academy, I could not express any confident opinion. But I am persuaded that the adoption of any definite policy which would be likely to reduce the membership to the vicinity of say 70 within a few years, and to keep it there, would be followed at once by the gift of a sum adequate to provide an income of $1,500 a year, to be divided among members attending the annual meeting, in partial reimbursement of the expenses to which they would thereby be subjected.

Will you present this statement to the National Academy, that the intending donor may learn whether it is advisable for him to take any action? He is diffident as to appearing to urge his views upon the Academy in any way which might appear meddlesome or presuming; yet the very statement of the proposition shows how nearly he has the usefulness and prosperity of the Academy at heart.

Very sincerely, yours,

B. A. GOULD.

CAMBRIDGE, MASS., *March 31, 1892.*

The president spoke of the importance of this matter. He stated that the offer of so large a sum of money could only come from a friend who had the best interests of the Academy at heart, and that the compliment thus paid the Academy was fully appreciated. He added that any action taken in the matter would evidently involve a change in the constitution. After reading Article VII of the constitution, he expressed the opinion that the Academy could not bind itself for the future; that if the proposition were accepted it could only be for the present, as the constitution might again be changed at the next annual meeting.

After considerable discussion it was moved that this matter be referred to the council. This motion was adopted.

AMENDMENT TO THE CONSTITUTION.

It was moved by Mr. Gibbs that section 5 of Article IV of the constitution be amended to read as follows:

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than two names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the four names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he received two-thirds of the votes cast and that his name appear on not less than twenty ballots: *and provided further*, that the number of members of the Academy be not already seventy-five or over, in which case, to be declared to be elected, he must receive three-fourths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than two members shall be elected in any one year.

The president read Article VII of the constitution, which regulates such matters, and the motion was referred to the council.

RESOLUTIONS.

The following resolutions were adopted by the Academy:

Resolved, That a committee of five members of the Academy be appointed by the president, whose duty it shall be to consider such amendments to the constitution as may be offered or suggested by any member of the Academy during the six months following the present meeting, and to report at the next stated session upon such proposed modifications of the constitution and by-laws of the Academy as are likely in their judgment to increase its efficiency as a means of advancing and conserving the interests of science in America.

Resolved, That it is the sense of the Academy that a reorganization into sections is desirable.

COMMITTEE ON AMENDMENTS TO THE CONSTITUTION.

The president appointed the following members as the committee to consider amendments to the constitution: T. C. Mendenhall, Chairman; H. P. Bowditch; W. H. Brewer; J. W. Powell; C. A. Young.

NEW MEMBERS.

The following new members were elected at this meeting: Messrs. Carl Barus, S. F. Emmons, and M. Cary Lea.

NOMINATIONS.

Four nominations for membership in the Academy were made at this meeting.

INVITATIONS.

The home secretary read a letter from the Secretary of the Cosmos Club, extending the privileges of the club to the members of the Academy during their meeting in Washington.

The home secretary also read an invitation to the Academy to send a representative to the tercentenary celebration of the University of Dublin, to be held in July, 1892.

Mr. Brush moved that this invitation be accepted and that the president be delegated to represent the Academy on that occasion. This motion was adopted.

The president accepted this nomination on condition that he might select a substitute in case he should not be able to attend.

(As the president was unable to attend, he subsequently appointed as delegate the vice-president, Mr. F. A. Walker, who represented the Academy on that occasion.)

Early in this meeting, the president announced that the naval Committee of the Senate had under consideration the question of the management of the Naval Observatory, and that members of the Academy were invited to appear before this committee in order to make known their personal views on the subject.

DEATH OF MEMBERS.

The president announced the death of the following members since the last meeting:

Prof. M. C. Meigs, January 2, 1892.
Prof. Joseph Lovering, January 18, 1892.
Prof. T. Sterry Hunt, February 12, 1892.
Prof. Sereno Watson, March 9, 1892.

The following members were appointed to prepare biographical memoirs:

Of Prof. Meigs, Gen. H. L. Abbot.
Of Prof. Lovering, Prof. J. P. Cooke.
Of Prof. Hunt, Prof. J. P. Lesley.
Of Prof. Watson, Prof. G. L. Goodale.

The Academy then adjourned to meet in Baltimore, Md., November 1, 1893.

SCIENTIFIC SESSION.

[Held at Baltimore, November 1 to 3, 1892.]

A scientific session for the reading of papers only having been called by the council, the Academy met at Johns Hopkins University, November 1, 1892, and the meetings were continued on the 2d and 3d.

The president, Prof. O. C. Marsh, presided at this meeting.

The following members were present during the session:

Abbe,	Chandler, S. C.,	Hague,	Mendenhall,
Barker,	Cope,	Hall, A.,	Morse,
Barus,	Dana, E. S.,	Hastings,	Newcomb,
Billings,	Emmons,	Hill, G. W.,	Remsen,
Brewer,	Gilbert,	Langley,	Rowland,
Brooks,	Gill,	Marsh,	Walker.

At this meeting the following papers were read:

(1) Gilbert, G. K.: The Evolution of the Moon.
(2) Mendenhall, T. C.: On the Observations for Latitude at Rockville, Md.

(3) Mendenhall, T. C.: On the Latitude Observations at Honolulu.

(4) Osborne, T. B., presented by S. W. Johnson: Crystallized Vegetable Proteids. (Read by Mr. Remsen.)

(5) Osborne, T. B., presented by S. W. Johnson: Proteids of the Flaxseed. (Read by title.)

(6) Rowland, H. A.: A Spectroscopic Analysis of the Rare Earths.

(7) Rowland, H. A.: A Table of Standard Wave-lengths.

(8) Rowland, H. A.: On the Motion of a Sphere in a Viscous Fluid.

(9) Williams, G. H., presented by Ira Remsen: Volcanic Rocks of South Mountain in Pennsylvania and Maryland.

(10) Remsen, Ira: On some Curious Double Halides.

(11) Remsen, Ira: Study of the Action of Light on Acids in Solutions containing a Salt of Uranium.

(12) Barus, C.: On Isothermals and Isometrics of Viscosity.

(13) Brooks, W. K.: Significance of the Follicle of Salpa. (Read by title.)

(14) Brooks, W. K.: Biological Relations of the Oldest Fossils.

(15) Cope, E. D.: On the Vertebrate Fauna of the Blanco Epoch.

(16) Chandler, S. C.: On the Motion of the Earth's Pole.

(17) Mendenhall, T. C.: The Use of Planes and Knife Edges in Pendulums.

(18) Hastings, C. S.: Recent Improvements in Astronomical Telescopes.

(19) Hale, G. E., presented by C. S. Hastings: Exhibition of Photographs illustrating New Methods and Results in Solar Physics.

(20) Squier, G. A., and Woff, F. A., jr., presented by H. A. Rowland: Some Effects of Magnetism on Chemical Action.

SPECIAL SESSION.

[Held at Baltimore, November 2, 1892.]

A special session of the Academy having been called by the council in accordance with Article III, section 1, of the constitution, the Academy met at Johns Hopkins University, November 2, 1892, the president, Prof. O. C. Marsh, presiding.

RECOMMENDATIONS FROM THE COUNCIL.

The home secretary read the following recommendations from the council, which were adopted by the Academy:

(1) That the president be authorized to include in his report to Congress the proceedings of the present meeting of the Academy, as well as those of the April meeting, and also any reports on Government business that may be submitted to the Academy.

(2) That the treasurer of the Academy be authorized to sell the 4 per cent. Government bonds now in the possession of the Academy (about $3,800), and to invest the proceeds of such sale under the advice of the investment committee.

ABSTRACT OF TREASURER'S REPORT.

The home secretary read a statement from the treasurer of the Academy, showing the condition of the invested funds of the Academy as follows:

Bache fund,	$50,444.37; interest per annum	$2,489.72
Watson fund,	18,666.88; interest per annum	945.07
Smith fund,	8,235.00; interest per annum	411.75
Draper fund,	6,603.75; interest per annum	330.18
Gibbs fund,	2,673.17; interest per annum	133.65

The cash balances on hand November 1, 1892, were as follows:

General fund	$210.36
Bache fund	1,029.93
Watson fund	1,333.34
Smith fund	2,085.97
Draper fund	1,234.70
Gibbs fund	66.82

The home secretary stated that Volume V of the memoirs had been printed and was being distributed; also, that the illustrations for Volume VI, Part 1, had been made, and that the printing would soon begin.

Mr. Mendenhall presented the report of the committee appointed to consider amendments to the constitution. The motion to refer this report to the council, with directions that the home secretary have it printed and sent to members of the Academy, was adopted.

NOMINATIONS.

Two nominations for membership in the Academy were made at this meeting.

The special session then adjourned.

RESOLUTION.

At the close of the scientific session the following resolution was unanimously adopted:

Resolved, That the thanks of the Academy are due and are hereby tendered to the president and trustees of the Johns Hopkins University for the excellent facilities which, through their kindness, have been provided for the meeting, and to Professors Remsen and Rowland for their continued and successful efforts to secure to the members that comfort and convenience in the transaction of business which has added so much to the pleasure and success of the meeting; also, to the officers and members of the University Club of Baltimore for their generosity in extending the hospitalities of the club to the members of the Academy during their stay in the city.

DEATH OF MEMBERS.

The president announced the death of Prof. Lewis M. Rutherfurd, who died May 30, 1892, near Hackettstown, N. J.; and of Prof. William P. Trowbridge, who died August 12, 1892, at New Haven, Conn.

The following members were appointed to prepare biographical memoirs:

Of Prof. L. M. Rutherfurd, Prof. B. A. Gould.

Of Prof. W. P. Trowbridge, Prof. C. B. Comstock.

The Academy then adjourned to meet in Washington in April, 1893.

Respectfully submitted.

O. C. MARSH,

President of the National Academy of Sciences.

APPENDICES.

APPENDIX A.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. LeConte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise;

to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March three, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 24, 1884.*

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

APPENDIX B.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883, and April 19, 1888.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States, on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by ap-

pointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution of the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its session next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered

by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special meetings may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election for officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected, and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president, and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author, or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be, at all times, at the dis-

position of the Government, upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receives two-thirds of the votes cast, it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the member were present.

RULES.

I. In the absence of any officer, a member shall be chosen to perform his duties temporarily, by a plurality of *viva voce* votes upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the

meeting at which the accounts are presented; which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year, and referred with the accounts to the auditing committee.

IV. A committee of arrangements consisting of five members shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members; to arrange the business of each day; to receive the titles of papers, reports, etc.; and to arrange the order of reading, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to fix the length of time to be devoted to reading of all papers submitted, and to limit the time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.
8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings shall be convened at noon.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session. But no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date in the records of the Academy from the date of their presentation to the Academy, and the order of their presentation shall be that in which they were registered, unless changed by consent of the author.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred, at the meeting at which they are read, to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. An annual of the Academy shall be prepared and published by the secretaries.

XIII. The printing of the Academy shall be under the charge of the committee of publication, to consist of the home secretary and four other members to be named by the president with the advice and consent of the council.

XIV. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XVI. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVII. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVIII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XIX. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XX. At least sixty days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XXI. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXII. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXIII. Any rule of the Academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, *ex officio*, a member of all Government committees of the Academy.

APPPENDIX C.

ORGANIZATION OF THE ACADEMY, 1892.

	Expiration of term.
MARSH, O. C., *President*	April, 1895
WALKER, F. A., *Vice-President*	April, 1897
GIBBS, WOLCOTT, *Foreign Secretary*	April, 1892
HALL, A., *Home Secretary*	April, 1895
BILLINGS, JOHN S., *Treasurer*	April, 1893

ADDITIONAL MEMBERS OF COUNCIL, 1892-'93.

BRUSH, G. J.
GOULD, B. A.
LANGLEY, S. P.
MENDENHALL, T. C.
NEWCOMB, S.
REMSEN, IRA.

COMMITTEES OF THE ACADEMY.

On Ways and Means to Provide a Fund for the Academy.

ROGERS, FAIRMAN, *Chairman.*
CHANDLER, C. F.
MARSH, O. C.
MITCHELL, S. WEIR.
PUMPELLY, R.

On Weights, Measures, and Coinage.

GIBBS, WOLCOTT.
GOULD, B. A.
MENDENHALL, T. C.
NEWCOMB, S.
NEWTON, H. A.
PEIRCE, C. S.
TROWBRIDGE, W. P.

On Election of Foreign Associates.

GIBBS, WOLCOTT, *Chairman.*
DANA, J. D.
GOULD, B. A.
HALL, A.
NEWCOMB, S.

On Reserving Public Lands on and near Mount Whitney, California, for Scientific Purposes.

LANGLEY, S. P., *Chairman.*
BREWER, W. H.
POWELL, J. W.

On Publication.

THE HOME SECRETARY.
BILLINGS, J. S.
MENDENHALL, T. C.
NEWCOMB, S.
POWELL, J. W.

On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.
BILLINGS, J. S.
BRUSH, G. J.
POWELL, J. W.

On Investigation of the North Magnetic Pole.

LANGLEY, S. P., *Chairman.*
ABBOT, H. L.
TROWBRIDGE, W. P.
MAYER, A. M.
SCHOTT, C. A.
TROWBRIDGE, J.
CARPMAEL, C.

On Uniformity of Measures in Physical Apparatus.

LANGLEY, S. P., *Chairman.*
MENDENHALL, T. C.
PICKERING, E. C.

On Amendments to the Constitution.

MENDENHALL, T. C., *Chairman.*
BOWDITCH, H. P.
BREWER, W. H.
POWELL, J. W.
YOUNG, C. A.

TRUST FUNDS.

Board of Direction of the Bache Fund.

GIBBS, W., *Chairman.*
DANA, J. D.
GOULD, B. A.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.*
GOULD, B. A.
HALL, A.

The Henry Draper Fund.

BARKER, G. F., *Chairman.*
GIBBS, W.
NEWCOMB, S.
WRIGHT, A. W.
YOUNG, C. A.

The J. Lawrence Smith Fund.

GIBBS, WOLCOTT, *Chairman.*
BRUSH, G. J.
HALL, A.
PUMPELLY, R.
RUTHERFURD, L. M.

The Barnard Medal.

CHANDLER, C. F., *Chairman.*
BOSS, LEWIS.
COOKE, J. P.
DANA, E. S.
GOODE, G. BROWN.

The Wolcott Gibbs Fund.

JACKSON, C. L.
REMSEN, IRA.
BROWN, T. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY, 1893.

		Date of election.
ABBE, CLEVELAND	*Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*Army Building, New York City.*	1872
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	*3909 Locust St., Philadelphia, Pa.*	1876
BARTLETT, WILLIAM H. C	*75 Locust Hill Ave., Yonkers, N. Y.*	——
BARUS, CARL	*Washington, D. C.*	1892
BELL, A. GRAHAM	*Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*Washington, D. C.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BROWN-SEQUARD, CHARLES E	*Paris, France.*	1868
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CASEY, THOMAS L., U. S. A	*Washington, D. C.*	1890
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	*16 Craigie St., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*Army Building, New York City.*	1881
COOKE, JOSIAH P	*Cambridge, Mass.*	1872
COPE, EDWARD D	*2100 Pine St., Philadelphia, Pa.*	1872
COUES, ELLIOTT	*Washington, D. C.*	1872
CRAFTS, JAMES M	*59 Marlborough St., Boston, Mass.*	1877
DANA, EDWARD S	*New Haven, Conn.*	1884
DANA, JAMES D	*New Haven, Conn.*	——
DAVIDSON, GEORGE	*San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Washington, D. C.*	1881
EMMONS, S. F	*Washington, D. C.*	1892
FARLOW, W. G	*Cambridge, Mass.*	1879
GENTH, FREDERICK A	*W. Philadelphia, Pa.*	1872
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
GOODE, G. BROWN	*Washington, D. C.*	1888
GOULD, BENJAMIN A	*Cambridge, Mass.*	——
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH, U. S. N	*Washington, D. C.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*Montmoor, N. Y.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*San José, Cal.*	1885

		Date of election.
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*New Haven, Conn.*	1866
KING, CLARENCE	*Century Club, New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LEA, M. CAREY	*430 Walnut St., Philadelphia, Pa.*	1892
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LESLEY, J. PETER	*1003 Clinton St., Philadelphia, Pa.*	——
MARSH, O. C	*New Haven, Conn.*	1874
MAYER, ALFRED M	*Hoboken, N. J.*	1872
MAYO-SMITH, RICHMOND	*Columbia College, New York City.*	1890
MENDENHALL, THOMAS C	*Washington, D. C.*	1887
MICHAEL, ARTHUR	*Somerville, Mass.*	1889
MICHELSON, ALBERT A	*Worcester, Mass.*	1888
MITCHELL, HENRY	*18 Hawthorne St., Boston, Mass.*	1885
MITCHELL, S. WEIR	*1534 Walnut St., Philadelphia, Pa.*	1865
MORSE, EDWARD S	*Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWCOMB, SIMON, U. S. N	*Washington, D. C.*	1869
NEWTON, H. A	*New Haven, Conn.*	——
NEWTON, JOHN, U. S. A	*New York City.*	1876
OLIVER, JAMES E	*Ithaca, N. Y.*	1872
PACKARD, A. S	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*Milford, Pa.*	1877
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs Ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	*147 S. Fourth St., Philadelphia, Pa.*	——
ROGERS, WILLIAM A	*Waterville, Me.*	1885
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
SCHOTT, CHARLES A	*Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	*1600 Hamilton St., Philadelphia, Pa.*	1873
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
TRUMBULL, J. H	*Hartford, Conn.*	1872
VERRILL, A. E	*New Haven, Conn.*	1872
WALKER, FRANCIS A	*Boston, Mass.*	1878
WHITE, CHARLES A	*Washington, D. C.*	1889
WOOD, HORATIO C	*1925 Chestnut St., Philadelphia, Pa.*	1879
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

HONORARY MEMBERS.

AGASSIZ, ALEXANDER	*Cambridge, Mass.*
LYMAN, THEODORE	*Brookline, Mass.*

DECEASED MEMBERS.

	Date of death.
*Agassiz, Louis	Dec. 14, 1873
*Alexander, J. H	Mar. 2, 1867
*Alexander, Stephen	June 25, 1883
*Bache, Alexander Dallas	Feb. 14, 1867
*Baird, Spencer F	Aug. 19, 1887
Barnard, F. A. P	Apr. 27, 1889
Barnard, J. G	May 14, 1882
*Caswell, Alexis	Jan. 8, 1887
*Chauvenet, William	Dec. 13, 1870
*Clark, Henry James	July 1, 1873
Coffin James H	Jan. 6, 1873
Coffin, J. H. C	Jan. 8, 1890
Cook, George H	Sept. 22, 1889
*Dalton, J. C	Feb. 2, 1889
Davis, Charles H	Feb. 18, 1877
*Draper, Henry	Nov. 20, 1882
*Draper, John W	Jan. 4, 1882
*Eads, James B	Mar. 8, 1887
Engelmann, George	Feb. 11, 1884
*Ferrel, William	Sept. 18, 1891
*Frazer, John Fries	Oct. 12, 1872
*Gabb, William M	May 30, 1878
*Gilliss, James Melville	Feb. 9, 1865
*Gould, Augustus A	Sept. 15, 1866
*Gray, Asa	Jan. 30, 1888
*Guyot, Arnold	Feb. 8, 1884
*Hadley, James	Aug. 1, 1864
*Haldeman, S. S	Sept. 10, 1880
Hayden, F. V	Dec. 22, 1887
*Henry, Joseph	May 13, 1878
Hilgard, Julius E	May 8, 1891
*Hitchcock, Edward	Feb. 27, 1864
*Holbrook, J. E	Sept. 8, 1871
*Hubbard, J. S	Aug. 16, 1863
*Humphreys, A. A	Nov. 28, 1883
Hunt, T. Sterry	Feb. 12, 1892
*Kirtland, Jared P	Dec. 10, 1877
*Lane, J. Homer	——, 1880
Le Conte, John	Apr. 29, 1891
*Le Conte, John L	Nov. 15, 1883
Leidy, Joseph	Apr. 30, 1891
*Lesquereux, Leo	Oct. 25, 1889
Longstreth, Miers F	Dec. 27, 1891
*Loomis, Elias	Aug. 16, 1889
Lovering, Joseph	Jan. 18, 1892
*Mahan, D. H	Sept. 16, 1871
*Marsh, G. P	July 23, 1882
*Meek, F. B	Dec. 21, 1877
Meigs, M. C	Jan. 2, 1892
*Morgan, Lewis H	Dec. 14, 1881

* Biographical notices have been presented of those designated by a *.

	Date of death.
NEWBERRY, J. S	Dec. 7, 1892
*NORTON, WILLIAM A	Sept. 21, 1883
PETERS, C. H. F	July 18, 1890
*POURTALES, L. F	July 17, 1880
RODGERS, JOHN	May 5, 1882
ROGERS, ROBERT E	Sept. 7, 1884
*ROGERS, WILLIAM B	May 30, 1888
RUTHERFURD, L. M	May 30, 1892
*SAXTON, JOSEPH	Oct. 26, 1873
*SILLIMAN, BENJ., SR	Nov. 24, 1864
SILLIMAN, BENJ., JR	Jan. 14, 1885
*SMITH, J. LAWRENCE	Oct. 12, 1883
*STIMPSON, WILLIAM	May 26, 1872
*STRONG, THEODORE	Feb. 1, 1869
*SULLIVANT, W. S	Apr. 30, 1873
*TORREY, JOHN	Mar. 10, 1873
*TOTTEN, J. G	Apr. 22, 1864
TROWBRIDGE, W. P	Aug. 12, 1892
*TUCKERMAN, EDWARD	Mar. 15, 1886
*WARREN, G. K	Aug. 8, 1882
*WATSON, JAMES C	Nov. 23, 1880
WATSON, SERENO	Mar. 9, 1892
*WINLOCK, JOSEPH	Jan. 11, 1875
*WOODWARD, J. J., U. S. A	Aug. 17, 1884
WORTHEN, A. H	May 6, 1888
*WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

AUWERS, ARTHUR	*Berlin.*
BERTHELOT, M. P. E	*Paris.*
BERTRAND, J. L. F	*Paris.*
BUNSEN, ROBERT W	*Heidelberg.*
CAYLEY, ARTHUR	*Cambridge.*
DE CANDOLLE, ALPHONSE	*Geneva.*
DU BOIS REYMOND, EMIL	*Berlin.*
GEGENBAUR, CARL	*Heidelberg.*
GYLDÉN, HUGO	*Stockholm.*
HELMHOLTZ, BARON H. VON	*Berlin.*
HOOKER, SIR JOSEPH D	*Kew.*
HUXLEY, THOMAS H	*London.*
KEKULÉ, AUGUST	*Bonn.*
KELVIN, LORD (Sir William Thomson)	*Glasgow.*
KÖLLIKER, ALBERT VON	*Würzburg.*
PASTEUR, LOUIS	*Paris.*
RICHTHOFEN, F. VON	*Berlin.*
STOKES, SIR GEORGE G	*Cambridge.*
STRUVE, OTTO VON	*Pulkova.*
SYLVESTER, J. J	*Oxford.*
VIRCHOW, RUDOLPH VON	*Berlin.*
WEIERSTRASS, KARL	*Berlin.*

*Biographical notices have been presented of those designated by a *.

DECEASED FOREIGN ASSOCIATES.

ADAMS, J. C.
AIRY, Sir GEORGE B.
ARGELANDER, F. W. A.
BAER, CARL ERNST VON.
BARRANDE, JOACHIM.
BEAUMONT, L. ELIE DE.
BOUSSINGAULT, J. B. J. D.
BRAUN, ALEXANDER.
BREWSTER, Sir DAVID.
BURMEISTER, C. H. C.
CHASLES, MICHEL.
CHEVREUL, M. E.
CLAUSIUS, RUDOLPH.
DOVE, H. W.
DUMAS, J. B.
FARADAY, MICHAEL.
HAMILTON, Sir WILLIAM ROWAN.
HOFMAN, A. W.
IBAÑEZ, CARLOS.
JOULE, JAMES P.
KIRCHOFF, G. R.
LIEBIG, JUSTUS VON.
MILNE-EDWARDS, HENRY.
MURCHISON, Sir RODERICK I.
OPPOLZER, THEODORE VON.
OWEN, Sir RICHARD.
PETERS, C. A. F.
PLANA, G. A. A.
REGNAULT, VICTOR.
STAS, JEAN SERVAIS.
WÖHLER, FRIEDRICH.
WÜRTZ, ADOLPHE.

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1893.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1895.

U. OF M.

Mail

LETTER

FROM

THE PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES,

TRANSMITTING

A report of the operations of the National Academy of Sciences during the year 1893.

JANUARY 11, 1894.—Referred to the Committee on Printing and ordered to be printed.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 10, 1894.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences during the past year.

Very respectfully,

O. C. MARSH,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

Mod

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

The National Academy of Sciences was established by act of Congress in March, 1863, with power to frame its own constitution, select its own members, and provide in other respects for its continuance and successful operation.

The object of the Academy is to advance science, and especially to investigate, examine, experiment, and report on any subject of science or art whenever called upon by any department of the Government.

The Academy contains at present about one hundred members, and these have all been selected for their original researches in science. They represent within their ranks nearly every department of knowledge, and their services, in accordance with the charter of the Academy, are always at the disposal of the Government without compensation.

SESSIONS OF THE NATIONAL ACADEMY.

During the past year the Academy has held three sessions. The first was the regular annual meeting, held in Washington, D. C., April 18 to 21, 1893; the second was a scientific session, in Albany, N. Y., November 7 to 9, 1893, and the third was a special session in Albany, November 8, 1893.

ANNUAL MEETING.

[Held in Washington City, April 18 to 21, 1893.]

The Washington session of the Academy was held in the National Museum, the president, Prof. O. C. Marsh, presiding.

The following members were present during the session: Abbe, Abbot, Barker, Barus, Bell, Billings, Brewer, Casey, Chandler (S. C.), Chittenden, Cope, Gibbs (W.), Gilbert, Gill, Goode, Gould, Hague, Hall (A.), Hill (G.W.), Hyatt, King, Langley, Marsh, Mayo-Smith, Mendenhall, Mitchell (S.W.), Newcomb, Packard, Powell, Remsen, Rowland, Schott, White, Young.

During this session the following papers were read and discussed:

1. Cope, E. D.: On the Systematic Relations of the Ophidia. Discussed by Mr. Gill.

2. Abbot, H. L.: Biographical Memoir of Gen. Montgomery C. Meigs.

3. Lea, M. C.: On the Nature of Certain Solutions, and on a New Means of Investigating Them. (Read by Mr. Barker.)

4. Hyatt, A.: The Relations of Allied Branches of Biological Research to the Study of the Development of the Individual, and the Evolution of Groups. Discussed by Mr. Cope.

5. Hyatt, A.: The Endosiphonoidea (*Endoceras*, etc.) Considered as a New Order of Cephalopods.

6. Hyatt, A.: A New Type of Fossil Cephalopods.

7. Hyatt, A.: Results of Recent Researches upon Fossil Cephalopods of the Carboniferous.

8. Hilgard, E. W.: Biographical Memoir of Julius Erasmus Hilgard. (Read by Mr. Mendenhall.)

9. Packard, A. S.: Monograph of the Bombycine Moths of America, North of Mexico: Part I—*Notodontidæ*.

10. Hill, G. W.: Intermediary Orbits.

11. Mayo-Smith, R.: The Relations Between the Statistics of Immigration and the Census Returns of the Foreign-born Population of the United States.

12. Mayo-Smith, R.: Statistical Data for the Study of the Assimilation of Races and Nationalities in the United States. Discussed by Messrs. Newcomb, Brewer, Gill, Mayo-Smith, and Billings.

13. Mendenhall, T. C.: Telegraphic Gravity Determinations.

14. Mendenhall, T. C.: Comparison of Latitude Determinations at Waikiki. Discussed by Mr. S. C. Chandler.

15. Carhart, H. S. (presented by T. C. Mendenhall): A One-volt Standard Cell.

16. Mendenhall, T. C.: Fundamental Standards of Length and Mass.

17. Chittenden, R. H.: Peptonization in Gastric Digestion. (Read by title.)

18. Bell, A. Graham: Helen Kellar.

19. Langley, S. P.: On a Potentiality of Internal Work in the Wind. (Read by title.)

20. Langley, S. P.: On a Bolograph of the Infra-red Solar Spectrum. (Read by title.)

21. Gill, T.: The Classification of the Gastropodous Mollusks. (Read by title.)

PRESENTATION OF THE FOURTH DRAPER MEDAL.

After the reading of the scientific papers was concluded, April 21, 1893, the president announced that the Academy, at a previous meeting, on recommendation of the committee on the Draper medal, had voted to award the fourth Henry Draper medal to Dr. Hermann Vogel, of Potsdam, Germany, whose spectroscopic observations upon the motion of stars in the line of sight, and other kindred researches, have made him especially worthy of this honor. A full account of this work is given in the report below.

In a brief address of presentation, the president gave a synopsis of this work, and stated that as Dr. Vogel was not present the medal would be forwarded to him through the German embassy at Washington.

REPORT OF THE COMMITTEE ON THE HENRY DRAPER MEDAL.

To the President of the National Academy of Sciences:

Prof. H. C. Vogel is at present the director of the Potsdam Observatory, near Berlin, and as such is the official head of German astronomical physics. His first appearance as an investigator dates from 1865, when he was an assistant in the Leipzig Observatory, under Bruhns. From 1870 to 1875 he was stationed at the Bothkamp Observatory, in Holstein, and while there made important observations on the spectra of the sun and the planets, together with others on the spectra of certain comets and a few stars. During the years 1875–1877 he resided at Berlin, awaiting the completion of the observatory building at Potsdam. Since his residence at Potsdam he has made many valuable investigations, among which may be mentioned his classification of star spectra and his measurements of wave length, the latter being made in connection with Muller. His catalogue of star spectra extends from zone $-1°$ to $+20°$, and includes 4,051 stars up to the seventh and a half magnitude. His measurements of wave length enabled him to construct a map of the spectrum of a high order of excellence, since superseded by the remarkable spectrum maps produced by Rowland. Dr. Vogel is therefore well known for his researches in astronomical physics, and has always shown himself accurate, energetic, and resourceful.

The special work for which your committee recommend the award to Dr. Vogel of the Henry Draper medal is his work upon the photography of star spectra, with especial reference to the motion of the stars along the line of vision, as determined by the displacement of their spectrum lines. The earliest attempts to determine the speed of stellar motions in the line of sight, by means of spectrum observations, were made by

Huggins in 1867, and consisted of eye observations entirely. They were successful as a demonstration of the correctness of the principle upon which they rested. Subsequently similar observations were continued at the Greenwich Observatory, and by Seabrooke at Rugby, but the results obtained have not been satisfactory, the probable error being at least ± 10 to 15 kilometers. Even much larger errors existed in these results, if we may judge by the discrepancy shown between the values given by different observations.

Dr. Vogel replaced eye observations by photography, following precisely the method of Dr. Draper, i. e., instead of using a slitless spectroscope of the form which has given such excellent results in the hands of Professor Pickering in a different line of work, he reverted to the slit spectroscope, which alone permits the comparison of the lines in a star spectrum with those of an electric spark in the way necessary to give a measurement of the star's motion.

In 1887 he had a provisional apparatus constructed with which he obtained results so encouraging that he at once proceeded to the construction of the larger spectrograph. This admirable instrument is fully described in the seventh volume of the Observations of the Potsdam Observatory. It was put into operation for the first time in September, 1888, and the particular work with which we are at present concerned was continued with it until the month of May, 1891.

More than 250 negatives were made of the spectra of the 51 brightest stars accessible to observation at Potsdam, a few plates being exposed to the spectra of Venus and the moon in order to test the adjustments of the apparatus. A majority of the exposures were made by Dr. Scheiner, Dr. Vogel's trusty lieutenant, but many of them were made by Dr. Vogel himself. These exposures ranged in length from twenty to ninety minutes. The comparison spectrum was obtained generally from a small hydrogen Geissler tube inserted into the tube of the large telescope, by means of which the image of the star was formed on the slit of the spectroscope.

The elaborate measurements and reductions of these plates are detailed in the volume already alluded to. They give us the motions of the stars observed with a degree of accuracy far exceeding those of all previous observers. The probable error of the star motion obtained from the measures of four good plates is only a little more than 1 English mile. The highest velocity observed in the list of 51 stars is that of α Tauri, which recedes at the rate of 30 miles a second. On the other hand, ν Leonis is approaching us at the rate of 24 miles a second. The mean of all the velocities observed is 10¼ miles a second.

An important collateral result secured by these investigations is the determination of a remarkably swift orbital motion in the case of certain stars. Thus Algol was found to be moving in a nearly circular orbit having a diameter of a little more than 2,000,000 miles, with a velocity of 20 miles a second. This amounts to a practical demonstration of the *surmise that the variations* in the light of this star are due to periodical

eclipses by a darker star of about half its size, which occur whenever, by the motion of the pair around their common center, the dark companion intervenes in the line of vision.

Moreover, this observation enables us for the first time to determine, with some approach to accuracy, the actual size of a star. Algol itself is shown in this way to have a diameter of approximately 1,060,000 miles, while its companion has a diameter of about 840,000 miles; magnitudes almost identical with that of our sun.

By these investigations made by Dr. Vogel, Spica Virginis is also shown to be moving similarly, with a period of four days, around a circle 6,000,000 miles in diameter, with a speed of 57 miles a second. It will be recollected that our colleague, Professor Pickering, about the same time, observed a similar phenomenon in β Aurigæ and in ζ Ursæ Majoris, indicated by a periodical doubling of the lines in its spectrum.

Since the committee voted to recommend the bestowal of the Henry Draper medal upon Dr. Vogel, it is interesting to note that he and his colleagues at Potsdam have made a most interesting series of photographs of the spectrum of the new star in Auriga.

GEORGE F. BARKER,
Chairman, Committee on the Henry Draper Medal.

HOME SECRETARY'S REPORT.

The home secretary read the following report, which was approved by the Academy:

During the past year, Volume V of the memoirs has been printed, and about 500 copies have been distributed. The president's annual report for 1891 has also been printed and distributed. The printing of the annual report for 1892 has been finished, and the printing of the memoirs for Volume VI commenced, about 100 pages being now in type.

REPORTS OF COMMITTEES.

The following reports from the various committees of the Academy were submitted during this meeting:

For the committee on ways and means to provide a fund for the Academy, Mr. S. Weir Mitchell reported that this committee had not been called together during the past year, and moved that it be discharged. This motion was seconded, and adopted by the Academy.

No report was received from the committee on weights, measures, and coinage. The president appointed Mr. C. A. Young to fill the vacancy in this committee caused by the death of Mr. W. P. Trowbridge.

Mr. W. Gibbs, chairman of the committee on the election of foreign associates, presented a report recommending the election of four new foreign associates to the Academy. Subsequently, three of these were elected. (See p. 16.)

Mr. Brewer stated that he was not aware that any work had been done during the year by the committee on reserving public lands on

and near Mount Whitney, Cal., for scientific purposes. On Mr. Powell's suggestion this committee was discharged, as the site in question is now a Government reservation.

Mr. Gill, for the committee on publications of the Academy, stated that he had no report to submit except that he had made additions to the list of articles.

For the committee on the investigation of the North Magnetic Pole, Mr. Abbot stated that a preliminary report had already been made, but that the committee had not been called together since. Mr. Langley, chairman, further stated that the committee ought to be continued.

Mr. Langley, chairman of the committee on uniformity of measures in physical apparatus, submitted no report, but stated that this committee should be continued, as it labors were important and interesting. Mr. Mendenhall added that a complete report would be made in the future.

On motion of Mr. Mendenhall, chairman of the committee on amendments to the constitution, it was voted by the Academy to increase this committee by the addition of two members. The president therefore appointed Dr. Billings and Mr. Remsen members of this committee. (See also p. 16.)

REPORTS ON TRUST FUNDS.

On behalf of the board of direction of the Bache fund, Mr. Gibbs, chairman, reported that requisitions had been made from this fund in favor of Louis Boss, $1,000, May 16, 1892; T. C. Mendenhall, $500, June 6, 1892; W. H. Edwards, $500, January 23, 1893. Mr. Mendenhall stated that the check for $500 placed at his disposal from this fund had not been used, and the money had been returned.

Mr. Newcomb, chairman of the board of trustees of the Watson fund, stated that business had been transacted as usual, but that he was not prepared to make a report, not having the necessary documents. Mr. Gould subsequently presented a report from the trustees of this fund, recommending that $500 be voted for the services of a computer to assist Mr. S. C. Chandler in his researches on the variation of latitude and on the constant of variation. Mr. Gould's motion that the Academy approve this action was seconded and adopted.

The following report from the committee on the Henry Draper fund was submitted by Mr. Barker, chairman, and on motion was adopted by the Academy:

In accordance with the deed of trust, the committee on the Henry Draper medal hereby approves the appropriation of $250 from the Henry Draper fund of the Academy to Prof. H. A. Rowland in aid of his researches upon the solar spectrum.

GEORGE F. BARKER, *Chairman.*
WOLCOTT GIBBS.
S. NEWCOMB.
C. A. YOUNG.

No report was received from the committee on the J. Lawrence Smith fund. The president appointed Mr. Remsen to fill the place on this committee made vacant by the death of Mr. Rutherfurd.

REPORT OF THE AUDITING COMMITTEE.

The following report of the auditing committee was submitted, and adopted by the Academy:

WASHINGTON, D. C., *April 18, 1893.*

The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances correspond to the vouchers, books, and accounts of the treasurer and are found correct.

THEO. N. GILL.
CHARLES A. SCHOTT.
G. W. HILL.

TREASURER'S REPORT.

To the President, National Academy of Sciences.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 18, 1893:

1. General fund, April 19, 1892, to April 18, 1893:	
Balance from April 19, 1892	$500.60
Invested income	*500.00
Interest received during 1892-93	18.26
Dues received from members	470.00
Total to account for	1,488.86
Disbursed during 1892-93	463.44
Balance, April 18, 1893	525.42
Invested income (bonds)	*500.00
Total accounted for	1,488.86
Available balance, less obligations	1,025.42
2. The Bache trust fund:	
Balance from April 19, 1892	4,025.08
Requisition, reimbursed	500.00
Interest received during 1892-93	1,996.83
Total to account for	6,521.91
Disbursed during 1892-93	2,869.45
Balance, April 18,1893	3,652.46
Total accounted for	6,521.91
Available balance, less obligations	2,212.74

*Invested in District of Columbia 3.65 per cent bonds.

3. The Watson trust fund:

Balance from April 19, 1892	$2.258.10
Invested income	*1,500.00
Interest received during 1892–93	1,028.79
Total to account for	4,786.89
Disbursed during 1892–93	602.01
Invested income, 1892–93	†826.83
Balance, April 18, 1893	1,858.05
Invested income (bonds)	*1,500.00
Total accounted for	4,786.89
Available balance, less obligations	5,358.05

4. The Draper medal fund:

Balance from April 19, 1892	1,078.61
Interest received during 1892–93	330.19
Total to account for	1,408.80
Disbursed during 1892–93	204.88
Balance, April 18, 1893	1,203.92
Total accounted for	1,408.80
Available balance, less obligations	1,203.92

5. The Smith medal fund:

Balance from April 19, 1892	1,874.25
Interest received during 1892–93	417.60
Total to account for	2,291.85
Invested income, 1892–93	‡596.57
Balance, April 18, 1893	1,695.28
Total accounted for	2,291.85
Available balance, less obligations	1,695.28

6. The Wolcott Gibbs fund:

Interest received during 1892–93	66.83
Disbursed during 1892–93	66.83

The following is a statement of the present investments of the Academy, showing the proportion of each belonging to the different special funds:

Bache fund:

Philadelphia 6 per cent bonds	$600.00
Dubant loan, 5 per cent	9,096.00
Hagner loan, 5 per cent	1,272.37
Dunlop loan, 5 per cent	8,530.00
Holtzman loan, 5 per cent	10,000.00
Clark loan, 5 per cent	7,500.00
Williamson and Kimmel loan, 5 per cent	4,596.00

* Invested in District of Columbia 3.65 per cent bonds.

† Invested in Earnshaw loan, 6 per cent.

‡ Invested in Webb loan, 5 per cent.

Bache fund—Continued.	
Mockbee loan, 5 per cent	$5,000.00
Lowenthal loan, 5 per cent	3,000.00
Webb loan, 5 per cent	1,403.43
Total	50,997.80
Watson fund:	
Dubant loan, 5 per cent	1,344.00
Hagner loan, 5 per cent	558.88
Cosmos Club bonds, first series, 5 per cent	500.00
Barber loan, 5 per cent	10,000.00
Ginesi loan, 6 per cent	1,000.00
Dunlop loan, 5 per cent	3,920.00
Williamson and Kimmel loan, 5 per cent	670.83
Cosmos Club bonds, new series, 5 per cent	500.00
Earnshaw loan, 6 per cent	173.17
Total	18,666.88
Draper fund:	
Hagner loan, 5 per cent	6,603.75
Smith fund:	
Dubant loan, 5 per cent	1,560.00
Hagner loan, 5 per cent	565.00
Dunlop loan, 5 per cent	4,550.00
Williamson and Kimmel loan, 5 per cent	1,560.00
Total	8,235.00
Gibbs fund:	
Williamson and Kimmel loan, 5 per cent	2,673.17
Invested income.	
General fund:	
District of Columbia 3.65 per cent bonds	$500.00
Watson fund:	
District of Columbia 3.65 per cent bonds	1,500.00
Earnshaw loan, 6 per cent	826.83
Total	2,326.86
Smith fund:	
Webb loan, 5 per cent	596.57

The following changes have occurred in the investments under the control of the National Academy of Sciences during the year:

On May 26, 1892, the loan made Joseph Redfern, November 2, 1889, was paid, and the money was reinvested in other loans. Under special authority from the National Academy, the United States 4 per cent bonds to the amount of $3,850.00, were sold, and the proceeds invested, namely, $4,403.43, in loans approved by the committee on investments. The Bache fund was increased by this transaction $553.43.

Statement showing increase of capital funds from years 1887 to 1893.

	1887.	1893.	Increase.
Bache fund	$47,550.00	$50,997.80	$3,447.80
Watson fund	13,750.00	18,666.88	4,916.88
Draper fund	5,000.00	6,603.75	1,603.75
Smith fund	7,200.00	8,235.00	1,035.00
Gibbs fund	.....	2,673.17	2,673.17
Income of general fund	500.00	500.00	.....
Income of Bache fund	1,500.00	2,326.83	826.83
Income of Watson fund	.....		
Income of Smith fund	.....	596.57	596.57
Total	75,500.00	90,600.00	15,100.00

In submitting this, my final report, I wish to make one or two recommendations which, it would seem, may properly come from an outgoing treasurer:

1. That the treasurer of the Academy should be a bonded officer; that the bonds should be furnished by one of the trust companies who make a business of furnishing such bonds, and the cost thereof should be defrayed by the Academy, being charged in due proportion to each of the funds under the control of the Academy.

2. That the trustees of each trust fund under the direction of the Academy should make a report each year to the Academy, stating the financial condition of their several funds, the orders for expenditures, etc. That these reports should be independent of the treasurer's report, and should be referred to the auditing committee of the treasurer's report in order that the necessary comparisons may be made.

Very respectfully,

JOHN S. BILLINGS,
Treasurer, National Academy of Sciences.

WASHINGTON, D. C., *April 18, 1893.*

REPORT OF THE COMMITTEE ON SECURITIES HELD BY THE ACADEMY.

The committee appointed to verify the securities held by the Academy presented the following report, which was approved:

1. GENERAL FUND.

District of Columbia 3.65 per cent bonds $500

2. BACHE TRUST FUND.

City of Philadelphia 6 per cent bonds $600

Land warrant No. 62749 for 160 acres of land, SE. ¼ sec. 11, T. 34, R. 23, Boonville, Mo. (This deed has not yet been transferred to the name of the Academy.)

3. JOSEPH HENRY FUND.

An agreement with the Pennsylvania company for insurance on lives and granting annuities, as to the final disposition of the Joseph Henry fund of $40,000. (This fund will not be available until the decease of all Professor Henry's children.)

4. WATSON TRUST FUND.

District of Columbia 3.65 per cent bonds	$1,500.00
Cosmos Club bonds, 5 per cent	500.00
Cosmos Club bonds, new series, 5 per cent	500.00
Total	2,500.00

5. DRAPER MEDAL FUND.

Deed of trust of Mary Anna Palmer Draper, giving $6,000 to the Academy as a special fund.

6. SMITH MEDAL FUND.

Deed of trust of Sarah Julia Smith, giving $8,000 to the Academy as a special fund.

The following papers were also found: Certificate of Riggs & Co., bankers, that they hold on deposit, for collection, notes as follows:

Dubant loan: One note for $12,000, interest semiannually at 5 per cent; payable October 28–November 1, 1895	$12,000
Hagner loan: One note for $9,000, interest semiannually at 5 per cent; payable July 15–18, 1894	9,000
Barber loan: One note for $10,000, interest semiannually at 5 per cent; payable August 5, 1894	10,000
Ginesi loan: One note for $1,000, interest semiannually at 6 per cent; payable January 2–5, 1897	1,000
Dunlop loan: One note for $17,000, interest semiannually at 5 per cent; payable April 16, 1897	17,000
Holtzman loan: One note for $10,000, interest semiannually at 5 per cent; payable May 4, 1897	10,000
Clark, et al., loan: Joint note for $7,500, interest semiannually at 5 per cent; payable May 6, 1895	7,500
Williamson and Kimmel loan: Joint notes for $9,500, interest semiannually at 5 per cent; payable May 2–5, 1897	9,500
Mockbee loan: One note for $5,000, interest semiannually at 5 per cent; payable May 13, 1897	5,000
Earnshaw loan: One note for $1,000, interest semiannually at 6 per cent; payable October 30–November 3, 1897	1,000
Lowenthal loan: Three notes for $1,000 each, interest semiannually at 5 per cent; payable December 1–3, 1897	3,000
Webb loan: One note for $2,000, interest semiannually at 5 per cent; payable November 18–21, 1897	2,000

Also one set of papers relating to each of the following loans, respectively: Dubant loan, Hagner loan, Ginesi loan, Geo. T. Dunlop loan, Holtzman loan, Wm. E. Clark, et al., loan, Williamson and Kimmel loan, and S. R. and W. T. Mockbee loan.

We certify that we have this day examined the securities and papers above described, and have found them to correspond to these lists.

ARNOLD HAGUE.
CARL BARUS.

WASHINGTON, D. C., *April 19, 1893.*

ELECTIONS.

The following members were elected for the council for the ensuing year: Messrs. Brush, Gould, Langley, Mendenhall, Newcomb, and Remsen.

The election of foreign secretary and treasurer, for a term of six years, took place on April 19, 1893, and resulted as follows: Foreign secretary, Prof. Wolcott Gibbs; treasurer, Dr. John S. Billings.

NEW FOREIGN ASSOCIATES.

The following gentlemen were elected as foreign associates of the Academy: Messrs. F. F. Tisserand, Paris; Karl F. Rammelsberg, Berlin; and Karl F. W. Ludwig, Leipsic.

RECOMMENDATIONS FROM THE COUNCIL.

The home secretary read the following recommendations from the council, which were adopted by the Academy:

1. That the membership fee for the ensuing year be fixed at $5.

2. That the treasurer of the Academy should be a bonded officer in the sum of $20,000; that the bonds should be furnished by one of the trust companies who make a business of furnishing such bonds, and the cost thereof should be defrayed by the Academy, being charged in due proportion to each of the funds under the control of the Academy.

3. That the trustees or the standing committees of each trust fund under the direction of the Academy should make a report each year to the Academy, stating the financial condition of their several funds, the order for expenditures which they have given, etc. That these reports should be independent of the treasurer's report, and should be referred to the auditing committee of the treasurer's report, in order that the necessary comparisons may be made.

4. That the report of the committee to consider amendments to the constitution of the Academy, presented November 2, 1892, be referred back to that committee for further consideration, with the request that the conclusions be presented at the next stated session in the form of a proposed formal amendment to the constitution, with a suggested classification of members.

DEATH OF MEMBERS.

The president announced the death of the following members, three of whom have died since the last meeting:

Prof. M. F. Longstreth, December 27, 1891; Prof. J. S. Newberry, December 7, 1892; Prof. F. A. Genth, February 2, 1893; Prof. W. H. C. Bartlett, February 11, 1893.

BIOGRAPHICAL MEMOIRS.

The president called attention to the delay which had occurred in the preparation of some biographical memoirs, and strongly urged greater promptness in future. He also appointed members to prepare such notices, as follows:

Of Prof. A. H. Worthen, by Prof. C. A. White; of Prof. M. F. Longstreth, by Prof. J. P. Lesley; of Prof. J. S. Newberry, by Mr. Clarence

King; of Prof. F. A. Genth, by Prof. G. F. Barker; of Prof. W. H. C. Bartlett, by Gen. T. L. Casey.

DEATH OF FOREIGN ASSOCIATE.

The president also announced the death of Sir Richard Owen, foreign associate of the Academy, who died December 18, 1892.

The Academy then adjourned to meet in scientific session in Albany, November 7, 1893.

SCIENTIFIC SESSION.

[Held in Albany, N. Y., November 7 to 9, 1893.]

A scientific session of the Academy, for the reading of papers only, having been called by the council, the Academy met in the Capitol at Albany, N. Y., November 7, 1893, and the meetings were continued on the 8th and 9th.

The president, Prof. O. C. Marsh, presided at these meetings, and the following members were present during the session: Boss, Brewer, Brush, Chandler (S. C.), Goodale, Hall (A.), Hall (J.), Hastings, Marsh, Morse, Newcomb, Walker.

During this scientific meeting the following papers were read and discussed:

1. Scudder, S. H.: American Paleozoic Cockroaches. (Read by title.)

2. Chandler, S. C.: Additional Researches on the Motion of the Earth's Pole.

3. White, C. A.: Biographical Memoir of A. H. Worthen. (Read by title.)

4. Comstock, C. B.: Biographical Memoir of W. P. Trowbridge. (Read by title.)

5. Hall, J.: The Geological Map of the State of New York.

6. Hastings, C. S.: On a New Form of Telescope Objective, as applied to the 12-inch Equatorial of the Dudley Observatory.

7. Beecher, C. E. (presented by A. Hyatt): On the Structure and Development of Trilobites.

8. Hall, A.: Double Stars.

9. Doolittle, C. L. (presented by L. Boss): Latitude Determinations at the Sayre Observatory. (Read by title.)

10. Lintner, J. A. (presented by J. Hall): Insect Voices.

11. Peck, C. H. (presented by J. Hall): Edible and Poisonous Fungi.

12. Morse, E. S.: A New Process of Printing in Color.

13. Cattell, J. McK., and Dolley, C. S. (presented by G. F. Barker): On Reaction—Times and the Velocity of the Nervous Impulse.

14. Hall, J.: The Paleontology of the State of New York; the Present Condition of the Work.

15. Goodale, G. L.: Certain Histological Relations between the Subalpine Plants of the White Hills and of the Labrador Coast.

SPECIAL SESSION.

[Held at Albany, November 8, 1893.]

A special session of the Academy having been called by the council, in accordance with Article III, section 1, of the constitution, the Academy met in the Capitol at Albany, November 8, 1893.

The president made a statement regarding the annual report to Congress, part of which he submitted to the Academy, and added that the report should contain, as heretofore, the proceedings of the present meeting in addition to those of the April session.

The president announced that he had received a letter from the chairman of the committee on amendments to the constitution, under date of November 3, 1893, stating that the report of this committee was not yet completed, but would be presented at the annual meeting in April, 1894. The president also announced the receipt of a communication from the chairman of the board of directors of the Bache fund, stating that the board had appointed Prof. George L. Goodale to fill the vacancy caused by the resignation of Prof. James D. Dana.

RECOMMENDATION FROM THE COUNCIL.

The following recommendation from the council was then adopted by the Academy:

That the Academy authorize the president to include in his report to Congress the proceedings of the present meeting, as well as those of the last April meeting, and also any reports on Government business that may come before the Academy.

REPORT FROM THE TRUSTEES OF THE WOLCOTT GIBBS FUND.

The home secretary read the following report from the trustees of the Wolcott Gibbs fund, which was received by him July 1, 1893:

The trustees of the Wolcott Gibbs fund for chemical research have the honor to report to the National Academy of Sciences that according to the statement of the treasurer, dated April 18, 1893, the capital of the fund amounted to $2,673.17, invested in the Williamson and Kimmel loan, secured by real estate, and bearing 5 per cent interest, to be paid semiannually.

The following vote was passed unanimously by the trustees, July 15, 1892:

Voted, That the annual income of the Wolcott Gibbs funds for chemical research be paid to Dr. Wolcott Gibbs, of Newport, during his life, to be used by him in whatever way will best promote his chemical investigations, and that the only vouchers required for the money

shall be his receipts sent to the treasurer of the National Academy of Sciences.

In accordance with this vote the treasurer will pay the income of the fund to Dr. Gibbs semiannually.

CHARLES L. JACKSON.
T. M. DROWN.
IRA REMSEN.

MAY, 1893.

This report was approved by the Academy.

RESOLUTION FROM THE TRUSTEES OF THE WATSON FUND.

The home secretary read the following resolution from the trustees of the Watson fund, which was adopted by the Academy:

Resolved, That the trustees of the Watson fund be authorized by the Academy to transfer such papers of the late Prof. James C. Watson as they think proper, from the Washburn Observatory at Madison, Wis., to the observatory at Ann Arbor, Mich.

ABSTRACT OF TREASURER'S REPORT.

The home secretary then read a statement from the treasurer of the Academy, giving the available balances from the several funds of the National Academy of Sciences, October 31, 1893, as follows:

General fund	*$210.37
Bache fund	1,421.16
Watson fund	†853.59
Draper fund	1,105.46
Smith fund	‡1,906.56

NOMINATIONS.

The home secretary read three nominations for membership in the Academy. These will be acted on at the April meeting, 1894.

The special session then adjourned.

On November 8, after the business session, the members of the Academy accepted an invitation to take part in the dedication of the new Dudley Observatory.

At the close of the scientific session, November 9, 1893, in accordance with a recommendation from the council, the home secretary was directed to express the thanks of the Academy to the Albany Institute, the trustees of the Dudley Observatory, the regents of the University of New York, the superintendent of public buildings, and the Fort

*There are also available $500 District of Columbia 3.65 bonds.

†The sum of $500 per annum is subject to the order of Professor Newcomb for work upon Watson's asteroids. There are also available the following: $1,500 in District of Columbia 3.65 bonds; $500 in Cosmos Club 5 per cent bonds; and $826.83 invested in Earnshaw loan, interest at 6 per cent.

‡$596.57 invested in Webb loan, interest at 5 per cent

Orange Club, for their kindness in providing such excellent accommodations for the meeting, and for their courtesies and hospitalities to the members of the National Academy during the session.

The Academy then adjourned to meet in Washington on the third Tuesday in April, 1894.

Respectfully submitted.

O. C. MARSH,
President of the National Academy of Sciences.

APPENDICES

APPENDIX A.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. LeConte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own

organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment and report upon, any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports, to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is thereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 24, 1884.*

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

APPENDIX B.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883, and April 19, 1888.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in

the office of treasurer or home secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution of the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its session next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by the majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any *meeting* shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special meetings may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election for officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected, and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president, and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author, or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be, at all times, at the dis-

position of the Government, upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receives two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the member were present.

RULES.

I. In the absence of any officer, a member shall be chosen to perform his duties temporarily, by a plurality of viva voce votes upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected by a plurality of members present to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented; which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year, and referred with the accounts to the auditing committee.

IV. A committee of arrangements consisting of five members shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members; to arrange the business of each day; to receive the titles of papers, reports, etc.; and to arrange the order of reading, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to fix the length of time to be devoted to reading of all papers submitted, and to limit the time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.

8 On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings shall be convened at noon.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time and report the date of their reception at the next session. But no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date in the records of the Academy from the date of their presentation to the Academy, and the order of their presentation shall be that in which they were registered, unless changed by consent of the author.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred, at the meeting at which they are read, to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. An annual of the Academy shall be prepared and published by the secretaries.

XIII. The printing of the Academy shall be under the charge of the committee of publication, to consist of the home secretary and four other members to be named by the president with the advice and consent of the council.

XIV. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XVI. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVII. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVIII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XIX. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XX. At least sixty days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XXI. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXII. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXIII. Any rule of the Academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, *ex officio*, a member of all Government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1893.

	Expiration of term.
MARSH, O. C., *President*	April, 1895
WALKER, F. A., *Vice-President*	April, 1897
GIBBS, WOLCOTT, *Foreign Secretary*	April, 1899
HALL, A., *Home Secretary*	April, 1895
BILLINGS, JOHN S., *Treasurer*	April, 1899

ADDITIONAL MEMBERS OF COUNCIL, 1893-94.

BRUSH, G. J.
GOULD, B. A.
LANGLEY, S. P.
MENDENHALL, T. C
NEWCOMB, S.
REMSEN, IRA.

COMMITTEES OF THE ACADEMY.

On Weights, Measures, and Coinage.

GIBBS, WOLCOTT.
GOULD, B. A.
MENDENHALL, T. C.
NEWCOMB, S.
NEWTON, H. A.
PEIRCE, C. S.
YOUNG, C. A.

On Election of Foreign Associates.

GIBBS, WOLCOTT, *Chairman.*
DANA, J. D.
GOULD, B. A
HALL, A.
NEWCOMB, S.

On Publication.

THE HOME SECRETARY.
BILLINGS, J. S.
MENDENHALL, T. C.
NEWCOMB, S.
POWELL, J. W.

On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.
BILLINGS, J. S.
BRUSH, G. J.
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X. Memoirs shall date in the records of the Academy from the date of their presentation to the Academy, and the order of their presentation shall be that in which they were registered, unless changed by consent of the author.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred, at the meeting at which they are read, to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

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XXIII. Any rule of the Academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, *ex officio*, a member of all Government committees of the Academy.

DEPARTMENT OF THE INTERIOR,
Washington, April 17, 1893.

SIR: I transmit herewith, for the consideration of the National Academy of Sciences, and such action as it may deem proper, a copy of a letter from the Commissioner of Education and accompanying inclosures, regarding the necessity for the fixing, with exactness, the six standard colors of the spectrum, and suggesting that the Academy determine whether the adoption of a conventional standard of color is feasible or desirable.

Very respectfully,

GEO. CHANDLER,
Acting Secretary.

Prof. O. C. MARSH,
President, National Academy of Sciences.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, April 14, 1893.

SIR: I have the honor to acknowledge the receipt, by reference from your office, of a letter from the Funk & Wagnall's Company, New York, bearing date the 1st instant, in which you are asked to request the National Academy of Sciences to appoint a committee to determine, with exactness, what are the six standard colors of the spectrum.

In compliance with your request for my recommendation upon this question I would say that the subject is undoubtedly an important one from a scientific, educational, and industrial point of view. The National Academy of Sciences is a body incorporated by the authority of Congress, act approved March 3, 1863, and is made the official adviser of the Government upon subjects within its province. It is composed of men of the highest ability and distinction in the various departments of scientific work. While any standard of colors must be arbitrary and conventional, yet such a standard as would doubtless be prepared under the auspices of the National Academy by the most skillful experts in the use of the spectroscope would be as satisfactory as any that could be devised, and would doubtless be accepted as authoritative in the arts and trades.

I therefore respectfully recommend that the question be submitted to the National Academy of Sciences whether the adoption of a conventional standard of colors is feasible or desirable; and if so, whether the Academy can undertake the task. Any communication upon the subject should be addressed to Prof. O. C. Marsh, president of the National Academy of Sciences, care of the Secretary of the Smithsonian Institution.

I return herewith the letter referred to with its inclosures, and would add that the National Academy of Sciences begins its sessions on the 18th instant in the National Museum.

I have the honor to be, very respectfully,

W. T. HARRIS, *Commissioner.*

The SECRETARY OF THE INTERIOR.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, D. C., March 8, 1893.

GENTLEMEN: Your letter of the 20th of February came during my absence from the city. It has been impossible to bring the matter of which you speak before the Secretary of the Interior just at this time when there is a change of Administration. The new Secretary is now installed, and I venture to suggest to you that you address a letter similar to the one sent me direct to the Secretary himself. I think the suggestion which you make is a good one and that it will receive consideration by the new Secretary, the Hon. Hoke Smith, Department of the Interior.

Very truly, yours,

W. T. HARRIS,
Commissioner.

Messrs. FUNK & WAGNALLS,
18 Astor Place, New York City.

FEBRUARY 20, 1893.

DEAR SIR: In the progress of the Standard Dictionary we have reached the word "color," and in that connection we have had prepared a table giving the composition of more than 400 varieties of color, under the direction of a prominent authority on this subject.

In order to make this table perfectly complete it will be necessary to have some one in authority say definitely and exactly what are the colors of the spectrum. In other words, we must have a definite meaning assigned to the popular idea of red, for instance, so that when red is indicated it shall mean that particular part of the spectrum between some very narrow limits.

Now, as this is largely a matter in which all educators are interested, it has been suggested to us that an appeal for an arbitrary definition of exactly what the spectrum colors are, and their exact location, made through the Secretary of the Interior to the National Academy of Sciences, would result in the appointment of a committee to settle the matter.

The importance of such a decision is manifest. It would then be possible for people to order wall-paper, colored fabrics, etc., from anywhere

in the United States, and elsewhere, by letter, without sending a sample. At present, if one orders something made of red or blue, anything included between the limits of the spectrum of the colors mentioned would fulfill the condition; but if conventionally red was said to be at such a point on the spectrum, and anything deviating from that point be regarded as red, plus so many points or minus so many points on the scale, seen through a spectroscope, the matter would then be very simple.

The treatment of this subject is one which should be instructive and valuable to scholars, and could be used by you in chart form similar to that containing rules for spelling and pronunciation of chemical terms.

You can also see that any attempt on our part to influence the National Academy would result in failure, as they would think we had some mercantile interest in the matter, whereas it makes no difference to us what standard is adopted or where the color is located, so long as some one in authority definitely states what the colors are.

In France such a standard exists and was originally made by the chemist Chevreul for the porcelain factory at Sevres. It consists of a porcelain slab showing the spectrum on which is a scale, so that red 245, for instance, if sent through the mails, is readily recognized by anyone in that country.

Hoping that you will give this matter your consideration, we remain, yours, very respectfully,

FUNK & WAGNALLS.

Hon. W. T. HARRIS, *Washington, D. C.*

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1894.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1895.

LETTER OF TRANSMITTAL.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 10, 1895.

SIR: In conformity with the requirements of the act of incorporation approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences during the past year.

Very respectfully, O. C. MARSH,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

The National Academy of Sciences was established by act of Congress in March, 1863, with power to frame its own constitution, select its own members, and provide in other respects for its continuance and successful operation.

The object of the Academy is to advance science, and especially to investigate, examine, experiment, and report on any subject of science or art whenever called upon by any department of the Government.

The Academy contains at present about one hundred members, and these have all been selected for their original researches in science. They represent within their ranks nearly every department of knowledge, and their services, in accordance with the charter of the Academy, are always at the disposal of the Government without compensation.

SESSIONS OF THE NATIONAL ACADEMY.

During the past year, the Academy has held three sessions. The first was the regular annual meeting, held in Washington, D. C., April 17 to 20, 1894. The second was a scientific session, in New Haven, Conn., October 30 to November 1, 1894; and the third was a special meeting in New Haven, October 31, 1894.

ANNUAL MEETING.

[Held in Washington City April 17 to 20, 1894.]

The Washington session was held in the National Museum, the president, Prof. O. C. Marsh, presiding.

The following members were present during the session:

Abbe,	Gibbs, W.,	Marsh,	Rowland,
Barker,	Gill,	Mayer,	Schott,
Barus,	Goodale,	Mayo-Smith,	Sellers,
Billings,	Goode,	Mendenhall,	Walker,
Brewer,	Gould,	Michelson,	White.
Casey,	Hague,	Morse,	Young.
Chandler, S. C.,	Hall, A.,	Newcomb,	
Cope,	Hastings,	Powell,	
mmons,	Langley,	Remsen,	

During this session the following papers were read and discussed:

(1) Goodale, G. L.: Histological Characteristics of Certain Alpine Plants.

(2) Goodale, G. L.: Corrosions by Roots.

(3) Comstock, G. C., presented by S. Newcomb: An Investigation of the Aberration and Atmospheric Refraction of Light, with a Modified Form of the Loewy Prism Apparatus. Discussed by Messrs. S. C. Chandler, Newcomb, and A. Hall.

(4) Le Conte, J.: Biographical Memoir of John Le Conte. (Read by Mr. Young.)

(5) Agassiz, A.: The Coral Reefs of the Bermudas. (Read by title.)

(6) Agassiz, A.: The so-called Serpulae Reefs of the Bermudas. (Read by title.)

(7) Agassiz, A.: The Bathymetrical Extension of the Pelagic Fauna. (Read by title.)

(8) Lea, M. C.: New Method of Determining the Relative Affinities of Certain Acids. (Read by Mr. Remsen.) Discussed by Mr. Barker.

(9) Mayer, A. M.: On the Change of Young's Modulus of Elasticity with Variation of Temperature, as Determined by the Transverse Vibration of Bars of Various Temperatures. Discussed by Messrs. Mendenhall and Mayer.

(10) Mayer, A. M.: On the Production of Beats and Beat-tones by the Covibration of two Sounds, so High in Pitch that, when Separately Sounded, they are Inaudible. Discussed by Messrs. Langley, Michelson, and Mayer.

(11) Mayer, A. M.: On the Motions of Resonators and other Bodies caused by Sound Vibrations, with Experimental Illustrations; also a Reclamation. Discussed by Mr. Barker.

(12) Chandler, S. C.: On Late Researches on the Variation of Latitude.

(13) Langley, S. P.: On the Infra-red Spectrum. Discussed by Messrs. Mendenhall, Langley, Young, and Michelson.

(14) Billings, J. S.: The Bacteria of River Water.

(15) Billings, J. S.: The Influence of Light upon the Bacillus of Typhoid, and the Colon Bacillus.

(16) Mendenhall, T. C.: Recent Gravity Instruments and Results. Discussed by Messrs. Newcomb, Mendenhall, Gilbert, Abbe, and Michelson.

(17) Gill, T.: The Geographical Distribution of Fresh-water Fishes. Discussed by Messrs. Cope, Gill, and Marsh.

(18) Hastings, C. S.: Note on a Possible Increase in the Ultimate Defining Power of the Microscope. (Read by title.)

(19) Langley, S. P.: The Internal Energy of the Wind. (Read by title.)

ELECTIONS.

The following members of the Academy were elected for the council for the ensuing year: Messrs. Brush, Gould, Langley, Mendenhall, Newcomb, and Remsen.

PRESIDENT'S REPORT.

The president stated that he had received last year a letter from the Secretary of the Interior, suggesting that the National Academy of Sciences determine whether the adoption of a conventional standard of color was feasible or desirable. After consulting with those familiar with the subject, the president informed the Secretary that he had ascertained that there were already standards of color sufficient for practical purposes, and that to obtain a new authoritative standard would require a long and expensive investigation, and the results might even then be of little value. Hence, he did not think it advisable to appoint a committee of the Academy for this purpose, unless this was specially desired by the Interior Department. To this letter no answer had been received.

The preliminary correspondence on this subject will be found in Appendix D of the Academy report for 1893.

HOME SECRETARY'S REPORT.

The home secretary submitted the following report for the past year:

WASHINGTON, *April 17, 1894.*

The printing of Volume VI of the memoirs was finished last December, and this volume has been distributed to members and associates and to foreign libraries.

Four biographical memoirs have been printed at the expense of the Academy. A few more are needed to complete the third volume of memoirs.

The Academy is very much indebted to the Smithsonian Institution for the distribution of its publications and for the storage of its books.

The home secretary added that the printing of the president's report for 1893 and the memoirs accompanying it had been favorably reported, but the Senate committee had under consideration a bill providing that the reports and memoirs of the Academy may be printed regularly without any special resolution.

The president stated that the bill providing for the printing of all reports and memoirs of the Academy passed the House last year, and is now in the hands of the Senate.

TREASURER'S REPORT.

WASHINGTON, D. C., *April 17, 1894.*

The PRESIDENT, NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 17, 1894:

(1) General fund:	
Balance from April 18, 1893	$525.42
Invested income	*500.00
Interest received in 1893–94	18.26
Annual dues from members	440.00
Total to account for	1,483.68
Disbursed in 1893–94	473.09
Balance (cash)	510.95
Balance (bonds and notes)	*500.00
Total accounted for	1,483.68
Available balance	510.59
(2) The Bache trust fund:	
Balance from April 18, 1893	3,652.46
Interest received in 1893–94	2,361.17
Reimbursed	160.20
Total to account for	6,173.83
Disbursed in 1893–94	2.354.94
Balance (cash)	3,818.89
Total accounted for	6,173.83
Available balance	1,018.12
(3) The Watson trust fund:	
Balance from April 18, 1893	1,858.05
Invested income	*1,500.00 †826.83
Interest received in 1893–94	971.91
Total to account for	5.156.79
Disbursed in 1893–94	734.19
Invested income	‡500.00 §1,000.00
Balance (cash)	595.77
Balance (bonds and notes)	†826.83 *1,500.00
Total accounted for	5,156.79
Available balance	595.77

* District of Columbia 3.65 bonds.

† Earnshaw loan at 6 per cent.

‡ Cosmos Club bonds.

§ Walter loan at 5½ per cent.

(4) The Draper medal fund:	
Balance from April 18, 1893	$1,203.92
Interest received in 1893–94	336.00
Total to account for	1,627.66
Disbursed in 1893–94	270.61
Balance (cash)	1,357.05
Total accounted for	1,627.66
Available balance	1,357.05
(5) The Smith medal fund:	
Balance from April 18, 1893	1,695.28
Invested income	*596.57
Interest received in 1893–94	336.00
Total to account for	2,627.85
Disbursed in 1893–94	10.10
Balance (cash)	2,021.18
Balance (bonds and notes)	596.57
Total accounted for	2,627.85
Available balance	2,021.18
(6) The Gibbs trust fund:	
Interest received in 1893–94	133.95
Total to account for	133.95
Disbursed in 1893–94	133.95

Statement of investments showing the proportion belonging to each fund.

General fund:	
Invested income, District of Columbia bonds, 3.65 per cent	$500.00
Bache fund:	
Philadelphia bonds, 6 per cent	600.00
Dubant loan, 5 per cent	9,096.00
Dunlop loan, 5 per cent	8,530.00
Holtzman loan, 5 per cent	10,000.00
Clark loan, 5 per cent	7,500.00
Williamson and Kimmel loan, 5 per cent	4,596.00
Mockbee loan, 5 per cent	5,000.00
Lowenthal loan, 5 per cent	3,000.00
Webb loan, 5 per cent	1,403.43
Walter loan, 5½ per cent	1,272.37
Total	50,997.80
Watson fund:	
Dubant loan, 5 per cent	1,344.00
Cosmos Club bonds (first series), 5 per cent	500.00
Barber loan, 5 per cent	10,000.00
Ginesi loan, 6 per cent	1,000.00
Dunlop loan, 5 per cent	3,920.00

*Webb loan at 5 per cent.

Watson fund—Continued.	
Williamson and Kimmel loan, 5 per cent	$670.83
Cosmos Club bonds (second series), 5 per cent	500.00
Earnshaw loan, 6 per cent	173.17
Walter loan, 5½ per cent	558.88
Total	18,666.88
Invested income—	
District of Columbia 3.65 bonds	1,500.00
Earnshaw loan, 6 per cent	826.83
Cosmos Club bonds (first series), 5 per cent	500.00
Walter loan, 5½ per cent	1,000.00
Total	3,826.83
Draper fund:	
Walter loan, 5½ per cent	6,603.75
Smith fund:	
Dubant loan, 5 per cent	1,560.00
Dunlop loan, 5 per cent	4,550.00
Williamson and Kimmel loan, 5 per cent	1,560.00
Walter loan, 5½ per cent	565.00
Total	8,235.00
Invested income, Webb loan	596.57
Gibbs fund:	
Williamson and Kimmel loan, 5 per cent	2,673.17

Under the advice and authority of the committee on investments, there were purchased during the past year five $100 bonds of the Cosmos Club, first series, from the surplus income of the "Watson" fund, at par with accrued interest, and bearing 5 per cent semiannually.

The "Hagner" loan was paid, with sixty days' interest, in advance, and a new loan for $10,000 was made with John Walter, jr., for five years, at 5½ per cent, wherein was invested from the surplus income of the "Watson" fund $1,000.

Respectfully submitted.

J. S. BILLINGS,
Treasurer, National Academy of Sciences.

REPORT OF THE COMMITTEE ON SECURITIES HELD BY THE ACADEMY.

Mr. Casey presented the report of the committee appointed to examine the securities of the Academy, which report, on motion of Mr. Gibbs, was accepted.

The report is as follows:

WASHINGTON, D. C., *April 9, 1894.*

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: The committee appointed by the president of the National Academy to examine the securities of the Academy in the hands of the treasurer has the honor to report that on the 9th of April, instant, we *met with the* treasurer at the Washington Safe Deposit Company, in this

city, and carefully examined the contents of the box of the National Academy of Sciences, finding within it the following list of securities and papers:

City of Philadelphia 6 per cent registered (2823 B), $600.

Land warrant No. 62749, for 160 acres of land, southeast quarter of section 11, township 34, range 23, Boonville, Mo. (This deed has not yet been transferred to the name of the Academy.)

Deed of trust, Mary Anna Palmer Draper, giving $6,000 to the Academy as a special fund.

Deed of trust, Sarah Julia Smith, giving $8,000 to the Academy as a special fund.

An agreement with the Pennsylvania Company for insurance in lives and granting annuities, as to the final disposition of the "Joseph Henry" fund, $40,000.

District of Columbia 3.65 bonds:	
No. 3435	$1,000.00
No. 3436	1,000.00
	2,000.00
Cosmos Club bonds:	
First series, Nos. 75–79, each $100	500.00
First series, Nos. 141–145, each $100	500.00
Second series, No. 260	500.00
	1,500.00

Certificate of Riggs & Co., bankers, that they hold on deposit, for collection, notes as follows:

One note for $12,000, given by Peter M. Dubant, interest semiannually, 5 per cent; payable September 28, 1895.

One note for $10,000, given by A. L. Barber, interest semiannually, 5 per cent; payable August 5, 1894.

One note for $1,000, given by Marianna Ginesi, interest semiannually, 6 per cent; payable January 2–5, 1897.

One note for $17,000, given by George Dunlop, interest semiannually, 5 per cent; payable April 16–19, 1897.

One note for $10,000, given by W. F. Holtzman, interest semiannually, 5 per cent; payable May 4–7, 1897.

One joint note for $7,500, given by W. C. Clark et al., interest semiannually, 5 per cent; payable May 6–9, 1895.

Two joint notes for $5,000 and $4,500, respectively, given by Williamson and Kimmel, interest semiannually, 5 per cent; payable May 2–5, 1897.

One note for $5,000, given by S. R. and W. F. Mockbee, interest semiannually, 5 per cent; payable May 13–16, 1897.

One note for $1,000, given by R. J. Earnshaw, interest semiannually, 6 per cent; payable October 30–November 3, 1897.

Three notes for $1,000 each, given by William Lowenthal, interest semiannually, 5 per cent; payable November 30–December 3, 1897.

One note for $2,000, given by H. Randall Webb, interest semiannually, 5 per cent; payable November 18–21, 1897.

Two notes for $5,000 each, given by John Walter, jr., interest semiannually, 5½ per cent; payable February 26–March 1, 1899.

One set of papers relating to Dubant loan.

One set of papers relating to Ginesi loan.

One set of papers relating to Dunlop loan.

One set of papers relating to Holtzman loan.

One set of papers relating to Clark et al. loan.
One set of papers relating to Williamson and Kimmel loan.
One set of papers relating to Mockbee loan.
One set of papers relating to Lowenthal loan.

We certify that we have this day examined the securities and papers above described, and find them to correspond with these lists.

THOS. LINCOLN CASEY.
S. F. EMMONS.

REPORT OF THE AUDITING COMMITTEE.

Mr. Brewer presented the following report of the auditing committee, which, on motion of Mr. White, was accepted:

WASHINGTON, D. C., *April 17, 1894.*

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances correspond to the vouchers, books, and accounts of the treasurer, and are found correct.

WM. SELLERS.
WM. H. BREWER.
EDW. S. MORSE.

Cash balance remaining on hand at examination of treasurer's accounts, April 17, 1894.

Income from investments:	
General fund	$510.59
Bache fund	3,818.89
Draper fund	1,357.05
Watson fund	595.77
J. Lawrence Smith fund	2,021.18
Wolcott Gibbs fund	
Total balance (Riggs & Co.)	8,303.48
Invested income:	
General fund (District of Columbia bonds, 3.65)	500.00
Watson fund (District of Columbia bonds, 3.65)	1,500.00
Watson fund (Earnshaw loan)	826.83
Watson fund (Cosmos Club bonds)	500.00
Watson fund (Walter loan)	1,000.00
J. Lawrence Smith fund (Webb loan)	596.57
Total	3,923.40

WM. SELLERS.
WM. H. BREWER.
EDW. S. MORSE.

REPORTS OF COMMITTEES.

The president stated that no meeting of the committee on the relation of the Academy to the Government had been held during the past *year.*

For the committee on uniformity of measures in physical apparatus, Mr. Mendenhall said that the question had been informally discussed during the past year, but so far as he knew there was no formal report to be made.

Mr. Mendenhall read a report from the committee on proposed amendments to the constitution of the Academy. This report was referred to the council. (See also pp. 14, 17.)

No report was received from the following committees: On weights, measures, and coinage; on the election of foreign associates; on publications of the Academy; and on the investigation of the north magnetic pole.

REPORTS FROM TRUST FUNDS.

BACHE FUND.

Mr. W. Gibbs presented the following report from the board of direction of the Bache fund, specifying the appropriations made during the year 1893:

May 31, 1893.—An appropriation of $1,000 to Dr. S. Weir Mitchell and Dr. John S. Billings to enable them to carry on an investigation of the effect of light, of dessication, and of the products of nitrification and of putrefaction upon the vitality and tonic properties of some of the pathogenic bacteria, including more especially those which pass off from the human body by the bowel, and the presence of which in sewage makes it specifically dangerous.

June 1, 1893.—An appropriation of $1,000 to Prof. Lewis Boss, director of the Dudley Observatory, at Albany, N. Y., to enable him to carry on an investigation of the proper motions of stars, with special reference to an inquiry as to the existence of any hitherto undiscovered systematic motions with a more comprehensive and exact investigation of the motion of the sun in space than has hitherto been attempted.

November 22, 1893.—An appropriation of $500 to Prof. W. K. Brooks for an investigation of the embryology of Lucifer.

December 19, 1893.—An appropriation of $1,000 to Prof. Henry A. Rowland to be employed in completing an investigation of all the lines of the solar spectrum and their identification with the chemical elements producing them.

WATSON FUND.

Mr. Newcomb presented a report from the board of trustees of the Watson fund, recommending that the Watson medal be awarded to Prof. S. C. Chandler for his researches during the past two years on the variations of latitude.

J. LAWRENCE SMITH FUND.

Mr. Gibbs read a letter from Mr. H. A. Newton regarding an appropriation for the purpose of photographing meteor tracks, and also a formal application from Messrs. Newton and Hastings, on behalf of the board of managers of Yale University Observatory, for an appropriation of $2,000 from the accumulated income of the J. Lawrence Smith fund, for the purpose of photographing the tracks of shooting stars.

This appropriation was recommended by Mr. Gibbs, and, on motion of Mr. Gould, was approved by the Academy.

COMMITTEE ON SECURING PUBLIC DOCUMENTS FOR MEMBERS OF THE ACADEMY.

Mr. Morse presented the following resolution, which was seconded, and adopted by the Academy:

Resolved, That a committee of five be appointed by the president, whose duty it shall be to arrange some method by which members of the National Academy of Sciences shall receive such Government publications as they may require.

The president therefore appointed the following members of the Academy to constitute this committee: Messrs. Mendenhall, Morse, Billings, Casey, and Powell.

The following resolution was adopted by the Academy, and was referred to this special committee:

Resolved, That, in the opinion of the Academy, it is extremely desirable to rescue from destruction the large amount of valuable scientific matter, such as serials, transactions of learned societies, as well as transient publications, which, as a matter of common experience, by reason of imperfect direction, loss of wrappers, etc., annually goes astray in the mails; and that, in its judgment, it is important that an inquiry be made as to the feasibility of securing the cooperation of the Post Office Department in rendering such scientific matter available for the purposes for which it was intended.

RECOMMENDATIONS FROM THE COUNCIL.

The following recommendations from the council were adopted by the Academy:

(1) That the name of Mr. Alexander Agassiz be transferred to the list of active members.

(2) That Part III of the Proceedings of the Academy be published, bringing them down to date.

(3) That the membership fee for the ensuing year be $5.

PROPOSED AMENDMENTS TO THE CONSTITUTION.

Mr. Billings proposed an amendment to the constitution, which was referred to the council. The council reported it back, with amendments. The Academy then resolved itself into a committee of the whole to consider this amendment, which was adopted, to be voted on at the next annual meeting. The amendment as adopted is as follows:

Add to Article IV a new section, as follows:

"SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the Academy, with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the Academy, and his name shall be dropped from the roll."

The Academy then, in committee of the whole, proceeded to consider the changes in the organization of the Academy, proposed by the committee on amendments, and a long discussion followed. Mr. Billings moved that the committee of the whole rise and report to the Academy that progress had been made, but that the business was not finished. This motion was adopted.

Mr. Mendenhall offered the following resolution, which was adopted:

Resolved, That the proposed amendments to the constitution be referred back to the special committee charged with the duty of considering them, with instructions to furnish a copy of the same as acted on by the Academy in committee of the whole at the April meeting of 1894, to each member of the Academy, and to obtain from each member an expression of his preference as to the class and section in which he desires to be enrolled, and to report the results of this inquiry, with such additional suggestions as it may deem proper, to the Academy at its stated business meeting in October, 1894.

INTERNATIONAL CONGRESS OF HYGIENE.

Mr. Remsen moved that the president be authorized to appoint a delegate to represent the Academy at the eighth International Congress of Hygiene and Demography, to be held at Budapest, September 1 to 9, 1894. This motion was adopted, and the president appointed Dr. John S. Billings delegate to that congress.

The home secretary read a communication from the Cosmos Club, stating that the courtesies of this club would be extended to the members of the National Academy of Sciences as usual during the Washington meeting.

DEATH OF MEMBER.

The president announced the death of Dr. Charles E. Brown-Séquard, a member of the Academy, who died in Paris, April 2, 1894.

Prof. H. P. Bowditch was appointed to prepare the biographical memoir.

The Academy then adjourned, to meet in scientific session at Yale University, New Haven, Conn., October 30, 1894.

SCIENTIFIC SESSION.

[Held at New Haven, Conn., October 30 to November 1, 1894.]

A scientific session for the reading of papers only having been called by the council, the Academy met at North Sheffield Hall, Yale University, October 30, 1894.

The president, Prof. O. C. Marsh, presided.

The following members were present during the session:

Barus.	Gibbs, W.	King.	Newton, H. A.
Boss.	Gould.	Langley.	Rogers, W. A.
Brewer.	Hall, A.	Marsh.	Scudder.
Brush.	Hall, J.	Mayo-Smith.	Smith.
Chandler, S. C.	Hastings.	Mendenhall.	Verrill.
Crafts.	Hill, G. W.	Michelson.	Walker.
Gibbs, J. W.	Johnson.	Morse.	Wright.

The scientific meetings continued three days, and the following papers were read and discussed:

(1) Rogers, W. A.: An Indirect Experimental Determination of the Energy of Obscure Heat.

(2) Rogers, W. A.: Determination of the Errors of the Circles of an electrotype copy of Tycho Brahe's Altitude Azimuth Instrument, now in possession of the Smithsonian Institution.

(3) Newton, H. A.: The Winnebago County, Iowa, Meteorites and the Meteor.

(4) Hill, G. W.: Literal Expression for the Motion of the Moon's Perigee.

(5) Brewer, W. H.: Atmospheric Dust and Aqueous Precipitation in Arctic Regions.

(6) Chandler, S. C.: Further Researches on the Polar Motion.

(7) Mendenhall, T. C.: The Relation of Gravity to Continental Elevation.

(8) Mendenhall, T. C.: The Legal Units of Electrical Measure.

(9) Hastings, C. S.: On Derived Equations in Optics.

(10) Hastings, C. S.: On a Method of Eliminating Secondary Dispersion, using Ordinary Silicate Glasses only.

(11) Osborne, T. B., introduced by S. W. Johnson: The Chemical Nature of Diastase.

(12) Beecher, C. E., introduced by O. C. Marsh: Some Features in the Development of Brachiopods. (Read by title.)

(13) Williams, H. S., introduced by O. C. Marsh: On the Presence of Devonian Fossils in Strata of Carboniferous Age.

(14) Billings, J. S.: On the Influence of Insolation upon Culture Media, and of Desiccation upon the Vitality of the Bacillus of Typhoid, of the Colon Bacillus, and of the Staphylococcus Aureus.

(15) Elkin, W. L., introduced by H. A. Newton: Report on Photographing Meteors.

(16) White, C. A.: Biographical Memoir of F. V. Hayden. (Read by title.)

(17) Verrill, A. E.: Geographical and Bathymetrical Distribution of the Deep Sea Echinoderms Discovered off the American Coast, north of Cape Hatteras.

(18) Michelson, A. A.: On the Effect of Pressure in Broadening Spectra Lines.

(19) Hall, J.: Remarks upon the Progress of Work upon a Handbook of the Brachiopoda.

(20) Hall, J.: Note upon the Occurrence and Distribution of the Dictyospongidæ in the Devonian and Carboniferous Formations.

(21) Langley, S. P.: Infra-red Spectrum.

(22) Gibbs, J. W.: On a certain Theorem in Theoretical Mechanics.

SPECIAL SESSION.

[Held at New Haven, October 31, 1894.]

A special session of the Academy having been called by the council, in accordance with Article III, section 1, of the constitution, the Academy met at North Sheffield Hall, Yale University, October 31, 1894, the president, Prof. O. C. Marsh, presiding.

The president submitted his annual report to Congress and the home secretary read the following recommendation from the council:

That the president be authorized to include in his annual report to Congress the proceedings of the present meeting, as well as those of the meeting in April, 1894; and also any matter relating to Government business that may be submitted to the Academy.

This recommendation was adopted by the Academy.

REQUEST FROM CONGRESS.

The president then called the attention of the Academy to the act of Congress of July 12, 1894, on the units of electrical measurements. This law made it the duty of the Academy to prescribe and publish specifications necessary for the practical application of the definitions of certain units of electrical measure adopted in the act. The president stated that he would first procure a certified copy of this act, and would then appoint a committee to carry out the requirements of the law. (See Appendix D, p. 39.)

REORGANIZATION OF THE ACADEMY.

Mr. Mendenhall stated that the committee on revising the constitution of the Academy had made some progress, and advised that the consideration of this question be deferred; also that the committee be authorized to print and send to members a new statement of their views. After discussion, Mr. Gibbs moved that this matter of revising the constitution be referred back to the committee, and postponed until the April meeting of the Academy in 1895. This motion was seconded and adopted.

NOMINATIONS.

Nominations for membership in the Academy were then read by the home secretary. These will be acted on at the meeting in Washington, in April, 1895.

The special session then adjourned.

DEATH OF MEMBER.

At the close of the scientific session, the president announced the death of Prof. Josiah P. Cooke, who died at Newport, R. I., September 3, 1894.

Prof. C. L. Jackson was appointed to prepare the biographical memoir.

DEATH OF FOREIGN ASSOCIATE.

The president also announced the death of Baron H. von Helmholtz, a foreign associate of the Academy, at Charlottenburg, September 8, 1894.

Mr. Gibbs moved that the home secretary be directed to present the thanks of the Academy to Yale University for the accommodations and courtesies to the Academy during its meetings. This motion was adopted by the Academy.

The Academy then adjourned, to meet in Washington the third Tuesday in April, 1895.

Respectfully submitted.

O. C. MARSH,
President of the National Academy of Sciences.

APPENDICES.

APPENDIX A.

AN ACT To incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Barlett, United States Military Academy, Missouri: U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, St. Louis, Missouri; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. LeConte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California, their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regula-

tions; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institutions, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports, to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT To amend the Act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN, *Chief Clerk.*

AN ACT To authorize the National Academy of Sciences to receive and hold trust funds for the promotion of Science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and the several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 24, 1884.*

A true copy.

SEVELLON A. BROWN, *Chief Clerk.*

APPENDIX B.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875, April 21, 1881, April 19, 1882, April 18, 1883, and April 19, 1888.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States, on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business; shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy

occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its sessions next ensuing, and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes, and the members present at any *meeting* shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special sessions may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election of officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he received two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case, to be declared to be elected, he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year, held in Washington, and not more than five members shall be elected at that session.

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election; otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members, to be appointed for that purpose by the president, and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary,

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be at all times at the dis-

position of the Government upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States; or, with the approval of the council, in State bonds, or first-mortgage bonds, or real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receive two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

RULES.

I. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of viva voce votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected, by a plu-

rality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented, which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property, owned or held in trust by the Academy, shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year and referred with the accounts to the auditing committee.

IV. A committee of arrangements, consisting of five members, shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members; to arrange the business of each day; to receive the titles of papers, reports, etc.; and to arrange the order of reading, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to fix the length of time to be devoted to reading of all papers submitted and to limit the time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.
8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings shall be convened at noon.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session. But no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date, in the records of the Academy, from the date of their presentation to the Academy, and the order of their presentation shall be that in which they were registered, unless changed by consent of the author.

XI. Papers from persons not members, read before the Academy and intended for publication, shall be referred, at the meeting at which they are read, to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. An Annual of the Academy shall be prepared and published by the secretaries.

XIII. The printing of the Academy shall be under the charge of the committee on publication, to consist of the home secretary and four other members to be named by the president, with the advice and consent of the council.

XIV. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XVI. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVII. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVIII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XIX. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XX. At least sixty days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XXI. Ballots for election of members may be sent by sealing them up in a blank envelope, and enclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXII. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXIII. Any rule of the Academy may be amended, suspended, or repealed, on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, *ex officio*, a member of all government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1894.

	Expiration of term.
MARSH, O. C., *President*	April, 1895
WALKER, F. A., *Vice-President*	April, 1897
GIBBS, WOLCOTT, *Foreign Secretary*	April, 1899
HALL, A., *Home Secretary*	April, 1895
BILLINGS, JOHN S., *Treasurer*	April, 1899

ADDITIONAL MEMBERS OF COUNCIL, 1894-95.

BRUSH, G. J.
GOULD, B. A.
LANGLEY, S. P.
MENDENHALL, T. C.
NEWCOMB, S.
REMSEN, IRA.

COMMITTEES OF THE ACADEMY.

On Weights, Measures, and Coinage.

GIBBS, WOLCOTT.
GOULD, B. A.
MENDENHALL, T. C.
NEWCOMB, S.
NEWTON, H. A.
PEIRCE, C. S.
YOUNG, C. A.

On the Election of Foreign Associates.

GIBBS, WOLCOTT, *Chairman.*
DANA, J. D.
GOULD, B. A.
HALL, A.
NEWCOMB, S.

On Publication.

THE HOME SECRETARY.
BILLINGS, J. S.
MENDENHALL, T. C.
NEWCOMB, S.
POWELL, J. W.

On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.
BILLINGS, J. S.
BRUSH, G. J.
POWELL, J. W.

Investigation of the North Magnetic Pole.

LANGLEY, S. P., *Chairman.*
ABBOT, H. L.
MAYER, A. M.
SCHOTT, C. A.
TROWBRIDGE, J.

On Uniformity of Measures in Physical Apparatus.

LANGLEY, S. P., *Chairman.* MENDENHALL, T. C.
PICKERING, E. C.

On Proposed Amendments to the Constitution.

MENDENHALL, T. C., *Chairman.* BREWER, W. H.
BILLINGS, J. S. POWELL, J. W.
BOWDITCH, H. P. REMSEN, IRA.
YOUNG, C. A.

On Securing Public Documents.

MENDENHALL, T. C., *Chairman.* CASEY, T. L.
BILLINGS, J. S. MORSE, E. S.
POWELL, J. W.

On Standards for Electrical Measure.

ROWLAND, H. A., *Chairman.* BARUS, C.
ABBOT, H. L. HASTINGS, C. S.
BARKER, G. F. MICHELSON, A. A.
TROWBRIDGE, J.

TRUST FUNDS.

Board of Direction of the Bache Fund.

GIBBS, WOLCOTT. GOULD, B. A.
GOODALE, G. L.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.* GOULD, B. A.
HALL, A.

The Henry Draper Fund.

BARKER, G. F., *Chairman.* NEWCOMB, S.
GIBBS, W. WRIGHT, A. W.
YOUNG, C. A.

The J. Lawrence Smith Fund.

GIBBS, WOLCOTT, *Chairman.* HALL, A.
BRUSH, G. J. PUMPELLY, R.
REMSEN, IRA.

The Barnard Medal.

CHANDLER, C. F., *Chairman.* COMSTOCK, C. B.
BOSS, LEWIS. DANA, E. S.
GOODE, G. B.

The Wolcott Gibbs Fund.

JACKSON, C. L. REMSEN, IRA.
DROWN, T. M.

		Date of election.
ABBE, CLEVELAND	*Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*Army Building, New York City.*	1872
AGASSIZ, ALEXANDER	*Cambridge, Mass.*	1866
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	*3909 Locust St., Philadelphia, Pa.*	1876
BARUS, CARL	*Washington, D. C.*	1892
BELL, A. GRAHAM	*Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*Washington, D. C.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CASEY, THOMAS L., U. S. A	*Washington, D. C.*	1890
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	*16 Craigie St., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*Army Building, New York City.*	1884
COPE, EDWARD D	*2100 Pine St., Philadelphia, Pa.*	1872
COUES, ELLIOTT	*Washington, D. C.*	1877
CRAFTS, JAMES M	*59 Marlborough St., Boston, Mass.*	1872
DANA, EDWARD S	*New Haven, Conn.*	1884
DANA, JAMES D	*New Haven, Conn.*	——
DAVIDSON, GEORGE	*San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Washington, D. C.*	1884
EMMONS, SAMUEL F	*Washington, D. C.*	1892
FARLOW, W. G	*Cambridge, Mass.*	1879
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
GOODE, G. BROWN	*Washington, D. C.*	1888
GOULD, BENJAMIN A	*Cambridge, Mass.*	——
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH	*Washington, D. C.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*West Nyack, N. Y.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*San José, Cal.*	1885
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*New Haven, Conn.*	1866

		Date of election.
KING, CLARENCE	*Century Club, New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LEA, M. CAREY	*430 Walnut St., Philadelphia, Pa.*	1892
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LESLEY, J. PETER	*1008 Clinton St., Philadelphia, Pa.*	——
MARSH, O. C	*New Haven, Conn.*	1874
MAYER, ALFRED M	*Hoboken, N. J.*	1872
MAYO-SMITH, RICHMOND	*Columbia College, New York City.*	1890
MENDENHALL, THOMAS C	*Worcester, Mass.*	1887
MICHAEL, ARTHUR	*Somerville, Mass.*	1889
MICHELSON, ALBERT A	*Chicago, Ill.*	1888
MITCHELL, HENRY	*18 Hawthorne St., Boston, Mass.*	1885
MITCHELL, S. WEIR	*1524 Walnut St., Philadelphia, Pa.*	1865
MORSE, EDWARD S	*Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWCOMB, SIMON, U. S. N	*Washington, D. C.*	1869
NEWTON, H. A	*New Haven, Conn.*	——
NEWTON, JOHN, U. S. A	*New York City.*	1876
OLIVER, JAMES E	*Ithaca, N. Y.*	1872
PACKARD, A. S	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*Milford, Pa.*	1877
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs Ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	*147 S. Fourth St., Philadelphia, Pa.*	——
ROGERS, WILLIAM A	*Waterville, Me.*	1885
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
SCHOTT, CHARLES A	*Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	*1600 Hamilton St., Philadelphia, Pa.*	1873
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
TRUMBULL, J. H	*Hartford, Conn.*	1872
VERRILL, A. E	*New Haven, Conn.*	1872
WALKER, FRANCIS A	*Boston, Mass.*	1878
WHITE, CHARLES A	*Washington, D. C.*	1889
WOOD, HORATIO C	*1925 Chestnut St., Philadelphia, Pa.*	1879
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

HONORARY MEMBER.

LYMAN, THEODORE	*Brookline, Mass.*

DECEASED MEMBERS.

	Date of death.
* AGASSIZ, LOUIS	Dec. 14, 1873
* ALEXANDER, J. H	March 2, 1867
* ALEXANDER, STEPHEN	June 25, 1883
* BACHE, ALEXANDER DALLAS	Feb. 14, 1867
* BAIRD, SPENCER F	Aug. 19, 1887
BARNARD, F. A. P	April 27, 1889

* Biographical notices have been presented of those designated by an asterisk.

	Date of death.
BARNARD, J. G	May 14, 1882
BARTLETT, W. H. C	Feb. 11, 1863
BROWN-SÉQUARD, CHARLES E	April 2, 1894
*CASWELL, ALEXIS	Jan. 8, 1887
*CHAUVENET, WILLIAM	Dec. 13, 1870
*CLARK, HENRY JAMES	July 1, 1873
COFFIN, JAMES H	Jan. 6, 1873
COFFIN, J. H. C	Jan. 8, 1890
COOK, GEORGE H	Sept. 22, 1889
COOKE, JOSIAH P	Sept. 3, 1894
*DALTON, J. C	Feb. 2, 1889
DAVIS, CHARLES H	Feb. 18, 1877
*DRAPER, HENRY	Nov. 20, 1882
*DRAPER, JOHN W	Jan. 4, 1882
*EADS, JAMES B	March 8, 1887
ENGELMANN, GEORGE	Feb. 11, 1884
*FERREL, WILLIAM	Sept. 18, 1891
*FRAZER, JOHN FRIES	Oct. 12, 1872
*GABB, WILLIAM M	May 30, 1878
GENTH, F. A	Feb. 2, 1893
*GILLISS, JAMES MELVILLE	Feb. 9, 1865
*GOULD, AUGUSTUS A	Sept. 15, 1866
*GRAY, ASA	Jan. 30, 1888
*GUYOT, ARNOLD	Feb. 8, 1884
*HADLEY, JAMES	Aug. 1, 1864
*HALDEMAN, S. S	Sept. 10, 1880
*HAYDEN, F. V	Dec. 22, 1887
*HENRY, JOSEPH	May 13, 1878
*HILGARD, JULIUS E	May 8, 1891
*HITCHCOCK, EDWARD	Feb. 27, 1864
*HOLBROOK, J. E	Sept. 8, 1871
*HUBBARD, J. S	Aug. 16, 1863
*HUMPHREYS, A. A	Nov. 28, 1883
HUNT, T. STERRY	Feb. 12, 1892
*KIRTLAND, JARED P	Dec. 10, 1877
*LANE, J. HOMER	——, 1880
*LE CONTE, JOHN	April 29, 1891
*LE CONTE, JOHN L	Nov. 15, 1883
LEIDY, JOSEPH	April 30, 1891
*LESQUEREUX, LEO	Oct. 25, 1889
LONGSTRETH, MIERS F	Dec. 27, 1891
*LOOMIS, ELIAS	Aug. 16, 1889
LOVERING, JOSEPH	Jan. 18, 1892
*MAHAN, D. H	Sept. 16, 1871
*MARSH, G. P	July 23, 1882
*MEEK, F. B	Dec. 21, 1877
*MEIGS, M. C	Jan. 2, 1892
*MORGAN, LEWIS H	Dec. 14, 1881
NEWBERRY, J. S	Dec. 7, 1892
*NORTON, WILLIAM A	Sept. 21, 1883
PETERS, C. H. F	July 18, 1890
*POURTALES, L. F	July 17, 1880
RODGERS, JOHN	May 5, 1882

*Biographical notices have been presented of those designated by an asterisk.

	Date of death.
ROGERS, ROBERT E	Sept. 7, 1884
* ROGERS, WILLIAM B	May 30, 1882
RUTHERFURD, LEWIS M	May 30, 1892
* SAXTON, JOSEPH	Oct. 26, 1873
* SILLIMAN, BENJ., Sr	Nov. 24, 1864
SILLIMAN, BENJ., Jr	Jan. 14, 1885
* SMITH, J. LAWRENCE	Oct. 12, 1883
* STIMPSON, WILLIAM	May 26, 1873
* STRONG, THEODORE	Feb. 1, 1869
* SULLIVANT, W. S	April 30, 1873
* TORREY, JOHN	March 10, 1873
* TOTTEN, J. G	April 22, 1864
* TROWBRIDGE, WILLIAM P	Aug. 12, 1892
* TUCKERMAN, EDWARD	March 15, 1886
* WARREN, G. K	Aug. 8, 1882
* WATSON, JAMES C	Nov. 23, 1880
* WATSON, SERENO	March 9, 1892
* WINLOCK, JOSEPH	June 11, 1875
* WOODWARD, J. J., U. S. A	Aug. 17, 1884
* WORTHEN, A. H	May 6, 1888
* WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

AUWERS, ARTHUR	*Berlin.*
BERTHELOT, M P. E	*Paris.*
BERTRAND, J. L. F	*Paris.*
BUNSEN, ROBERT W	*Heidelberg.*
CAYLEY, ARTHUR	*Cambridge*
DU BOIS REYMOND, EMIL	*Berlin.*
GEGENBAUR, CARL	*Heidelberg.*
GYLDÉN, HUGO	*Stockholm.*
HOOKER, SIR JOSEPH D	*Kew.*
HUXLEY, THOMAS H	*London.*
KEKULÉ, AUGUST	*Bonn.*
KELVIN, LORD (Sir William Thompson)	*Glasgow.*
KÖLLIKER, ALBERT VON	*Würzburg.*
LUDWIG, K. F. W	*Leipzig.*
PASTEUR, LOUIS	*Paris.*
RAMMELSBERG, K. F	*Berlin.*
RICHTHOFEN, F. VON	*Berlin.*
STOKES, SIR GEORGE G	*Cambridge.*
STRUVE, OTTO VON	*Pulkova.*
SYLVESTER, J. J	*Oxford.*
TISSERAND, F. F	*Paris.*
VIRCHOW, RUDOLPH VON	*Berlin.*
WEIERSTRASS, KARL	*Berlin.*

* Biographical notices have been presented of those designated by an asterisk.

DECEASED FOREIGN ASSOCIATES.

ADAMS, J. C.
AIRY, SIR GEORGE B.
ARGELANDER, F. W. A.
BAER, CARL ERNST VON.
BARRANDE, JOACHIM.
BEAUMONT, L. ELIE DE.
BOUSSINGAULT, J. B. J. D.
BRAUN, ALEXANDER.
BREWSTER, SIR DAVID.
BURMEISTER, C. H. C.
CANDOLLE, ALPHONSE DE.
CHASLES, MICHEL.
CHEVREUL, M. E.
CLAUSIUS, RUDOLPH.
DOVE, H. W.
DUMAS, J. B.
FARADAY, MICHAEL.
HAMILTON, SIR WILLIAM ROWAN.
HELMHOLTZ, BARON H. VON.
HOFMAN, A. W.
IBAÑEZ, CARLOS.
JOULE, JAMES P.
KIRCHOFF, G. R.
LIEBIG, JUSTUS VON.
MILNE-EDWARDS, HENRY.
MURCHISON, SIR RODERICK I.
OPPOLZER, THEODORE VON.
OWEN, SIR RICHARD.
PETERS, C. A. F.
PLANA, G. A. A.
REGNAULT, VICTOR.
STAS, JEAN SERVAIS.
WÖHLER, FRIEDRICH.
WÜRTZ, ADOLPHE.

APPENDIX D.

STANDARDS FOR ELECTRICAL MEASURE.

In July, 1894, an act of Congress was passed to define and establish the units of electrical measure. By this law Congress made it the duty of the National Academy of Sciences to prescribe and publish specifications necessary for the practical application of the definitions of certain units of electrical measure adopted in the act. This law is as follows:

AN ACT TO DEFINE AND ESTABLISH THE UNITS OF ELECTRICAL MEASURE.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the passage of this Act the legal units of electrical measure in the United States shall be as follows:

First. The unit of resistance shall be what is known as the international ohm, which is substantially equal to one thousand million units of resistance of the centimeter-gram-second system of electro-magnetic units, and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice fourteen and four thousand five hundred and twenty-one ten-thousandths grams in mass, of a constant cross-sectional area, and of the length of one hundred and six and three tenths centimeters.

Second. The unit of current shall be what is known as the international ampere, which is one-tenth of the unit of current of the centimeter-gram-second system of electro-magnetic units, and is the practical equivalent of the unvarying current, which, when passed through a solution of nitrate of silver in water in accordance with standard specifications, deposits silver at the rate of one thousand one hundred and eighteen millionths of a gram per second.

Third. The unit of electro-motive force shall be what is known as the international volt, which is the electro-motive force that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of an international ampere, and is practically equivalent to one thousand fourteen hundred and thirty-fourths of the electro-motive force between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of fifteen degrees

centigrade, and prepared in the manner described in the standard specifications.

Fourth. The unit of quantity shall be what is known as the international coulomb, which is the quantity of electricity transferred by a current of one international ampere in one second.

Fifth. The unit of capacity shall be what is known as the international farad, which is the capacity of a condenser charged to a potential of one international volt by one international coulomb of electricity.

Sixth. The unit of work shall be the Joule, which is equal to ten million units of work in the centimeter-gram-second system, and which is practically equivalent to the energy expended in one second by an international ampere in an international ohm.

Seventh. The unit of power shall be the Watt, which is equal to ten million units of power in the centimeter-gram-second system, and which is practically equivalent to the work done at the rate of one Joule per second.

Eighth. The unit of induction shall be the Henry, which is the induction in a circuit when the electro-motive force induced in this circuit is one international volt while the inducing current varies at the rate of one Ampere per second.

SEC. 2. That it shall be the duty of the National Academy of Sciences to prescribe and publish, as soon as possible after the passage of this Act, such specifications of details as shall be necessary for the practical application of the definitions of the ampere and volt hereinbefore given, and such specifications shall be the standard specifications herein mentioned.

Approved, July 12, 1894.

[CORRESPONDENCE.]

UNITED STATES COAST AND GEODETIC SURVEY,
Washington, D. C., September 12, 1894.

SIR: I beg to invite your attention to the recent enactment by Congress of a law defining standards for electrical measurement, in which it is provided that certain specifications shall be furnished by the National Academy of Sciences. As these specifications are necessary to the perfecting of this important legislation, I respectfully urge early action on the part of the Academy. A copy of the law is inclosed herewith.

Respectfully, T. C. MENDENHALL,
Superintendent, United States Coast and Geodetic Survey and of Weights and Measures.

Prof. O. C. MARSH,
President, National Academy of Sciences.

NOTE.—The above letter with its inclosure was received by the president of the Academy from Professor Mendenhall personally, October 31, 1894, at New Haven, Conn.

YALE UNIVERSITY,
New Haven, Conn., November 6, 1894.

SIR: I received on the 31st ultimo a printed document purporting to be a copy of an act passed by the last Congress, and approved July 12, 1894, entitled "An act to define and establish the units of electrical measure."

By this act it becomes the duty of the National Academy of Sciences to prescribe and publish specifications necessary for the practical application of the definitions of the units of electrical measure adopted in the act.

Before commencing the work thus intrusted to the National Academy of Sciences, it is important for me to have an official copy of the law itself. I write, therefore, to ask if you will kindly have a certified copy of this act sent to me.

Very respectfully, O. C. MARSH,
President of the National Academy of Sciences.

Hon. WALTER Q. GRESHAM,
Secretary of State.

DEPARTMENT OF STATE,
Washington, November 8, 1894.

SIR: In reply to your letter of the 6th instant, a certified copy of the act of July 12, 1894, "An act to define and establish the units of electrical measure," has been mailed to you.

I am, sir, your obedient servant,

ANDREW H. ALLEN,
Chief of Bureau of Rolls and Library.

Prof. O. C. MARSH,
Yale University, New Haven, Conn.

YALE UNIVERSITY,
New Haven, Conn., November 9, 1894.

DEAR SIR: I have this day received from the United States State Department an official copy of a law passed at the last session of Congress, and approved July 12, 1894, entitled "An act to define and establish the units of electrical measure," a copy of which I inclose.

By this law, Congress makes it the duty of the National Academy of Sciences to prescribe and publish specifications necessary for the practical application of the definitions of certain units of electrical measure adopted in the act.

To comply with this request of Congress it is necessary for me, first

of all, to appoint a special committee of the Academy to investigate the subject. This committee will be as follows:

Prof. H. A. Rowland, chairman, Johns Hopkins University, Baltimore.
Prof. T. C. Mendenhall, Polytechnic Institute, Worcester, Mass.
Gen. H. L. Abbot, United States Engineers, New York.
Prof. G. F. Barker, University of Pennsylvania, Philadelphia.
Prof. J. Trowbridge, Harvard University, Cambridge.
Prof. C. S. Hastings, Yale University, New Haven.
Dr. C. Barus, Smithsonian Institution, Washington.

It is important to have this work completed as soon as possible, so that the report of the committee may be submitted to the National Academy of Sciences before being transmitted to Congress.

Very respectfully,

O. C. MARSH,
President of the National Academy of Sciences.

Prof. H. A. ROWLAND,
Johns Hopkins University.

POSTSCRIPT.

The members of the National Academy of Sciences thus selected for this committee all accepted the appointment offered except Professor Mendenhall. A position on this committee was subsequently offered to Prof. A. A. Michelson, of Chicago University, and accepted by him.

The committee thus constituted has made good progress in the work intrusted to them, and it is expected that their report will be completed by the end of the present month. If so, a special meeting of the Academy will be called without delay, and the report submitted to the Academy as a whole, after which it will be transmitted directly to Congress, in accordance with the act of July 12, 1894.

JANUARY, 1895.

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1895.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

LETTER

FROM

THE PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES,

TRANSMITTING

A report of the operations of the National Academy of Sciences during the year 1895.

JANUARY 3, 1896.—Referred to the Committee on Printing and ordered to be printed.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 1, 1896.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences during the past year.

Very respectfully, WOLCOTT GIBBS,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

ACT OF INCORPORATION.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. LeConte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise;

to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 24, 1884.*

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

SESSIONS OF THE NATIONAL ACADEMY.

During the year 1895 the Academy held four sessions. The first was a special session, held in New York, February 9. The second was the regular annual meeting, held at Washington, April 16 to 19. The third was a scientific session, held in Philadelphia, October 30 to November 1, and the fourth a special meeting, held at Philadelphia, October 31, for the transaction of business.

SPECIAL MEETING.

[New York, February 9, 1895.]

This meeting was held at Columbia College, the president, Prof. O. C. Marsh, presiding.

The following named members were present during the session: Marsh, Abbot, Barker, Billings, Brewer, Chandler (C. F.), Comstock, Gould, Hastings, Mayer, Mayo-Smith, Michelson, Rood, Rowland, Walker.

No papers were read at this session, which was called for business only, namely, to comply with a law of Congress entitled "An act to define and establish the units of electrical measure," approved July 12, 1894, and announced to the Academy at the special meeting in New Haven, October 31, 1894. The president, Mr. Marsh, informed the Academy that on receiving a certified copy of the law from the Department of State he had appointed a special committee to investigate the subject. The act in question is as follows:

AN ACT to define and establish the units of electrical measure.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the passage of this Act the legal units of electrical measure in the United States shall be as follows:

First. The unit of resistance shall be what is known as the international ohm, which is substantially equal to one thousand million units of resistance of the centimeter-gram-second system of electro-magnetic units, and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice fourteen and four thousand five hundred and twenty-one

ten-thousandths grams in mass, of a constant cross-sectional area, and of the length of one hundred and six and three-tenths centimeters.

Second. The unit of current shall be what is known as the international ampere, which is one-tenth of the unit of current of the centimeter-gram-second system of electro-magnetic units, and is the practical equivalent of the unvarying current, which, when passed through a solution of nitrate of silver in water in accordance with standard specifications, deposits silver at the rate of one thousand one hundred and eighteen millionths of a gram per second.

Third. The unit of electro-motive force shall be what is known as the international volt, which is the electro-motive force that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of an international ampere, and is practically equivalent to one thousand fourteen hundred and thirty-fourths of the electro-motive force between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of fifteen degrees centigrade, and prepared in the manner described in the standard specifications.

Fourth. The unit of quantity shall be what is known as the international coulomb, which is the quantity of electricity transferred by a current of one international ampere in one second.

Fifth. The unit of capacity shall be what is known as the international farad, which is the capacity of a condenser charged to a potential of one international volt by one international coulomb of electricity.

Sixth. The unit of work shall be the joule, which is equal to ten million units of work in the centimeter-gram-second system, and which is practically equivalent to the energy expended in one second by an international ampere in an international ohm.

Seventh. The unit of power shall be the watt, which is equal to ten million units of power in the centimeter-gram-second system, and which is practically equivalent to the work done at the rate of one joule per second.

Eighth. The unit of induction shall be the henry, which is the induction in a circuit when the electro-motive force induced in this circuit is one international volt while the inducing current varies at the rate of one ampere per second.

SEC. 2. That it shall be the duty of the National Academy of Sciences to prescribe and publish as soon as possible after the passage of this Act, such specifications of details as shall be necessary for the practical application of the definitions of the ampere and volt hereinbefore given, and such specifications shall be the standard specifications herein mentioned.

To meet this requirement of Congress it was necessary, in accordance with the constitution of the National Academy of Sciences, to appoint a special committee to consider the subject. This was done as soon as an official copy of the law was received from the State Department. The committee, selected from members of the National Academy, was as follows:

Prof. H. A. Rowland, chairman, Johns Hopkins University, Baltimore.
Gen. H. L. Abbot, United States Engineers, New York.
Prof. G. F. Barker, University of Pennsylvania, Philadelphia.
Prof. J. Trowbridge, Harvard University, Cambridge.
Prof. C. S. Hastings, Yale University, New Haven.
Dr. C. Barus, Smithsonian Institution, Washington.
Prof. A. A. Michelson, University of Chicago, Chicago.

The committee completed the work assigned to them. The specifications they prepared meet the requirement of the law, and are also in accord with international agreement. These specifications are as follows:

SPECIFICATIONS FOR THE PRACTICAL APPLICATION OF THE DEFINITIONS OF THE AMPERE AND VOLT.

SPECIFICATION A.—*The ampere.*

In employing the silver voltameter to measure currents of about 1 ampere, the following arrangements shall be adopted:

The kathode on which the silver is to be deposited shall take the form of a platinum bowl not less than 10 centimeters in diameter and from 4 to 5 centimeters in depth.

The anode shall be a disk or plate of pure silver some 30 square centimeters in area and 2 or 3 millimeters in thickness.

This shall be supported horizontally in the liquid near the top of the solution by a silver rod riveted through its center. To prevent the disintegrated silver which is formed on the anode from falling upon the kathode, the anode shall be wrapped around with pure filter paper, secured at the back by suitable folding.

The liquid shall consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water.

The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

Method of making a measurement.—The platinum bowl is to be washed consecutively with nitric acid, distilled water, and absolute alcohol; it is then to be dried at 160° C., and left to cool in a desiccator. When thoroughly cool it is to be weighed carefully.

It is to be nearly filled with the solution and connected to the rest of the circuit by being placed on a clean insulated copper support to which a binding screw is attached.

The anode is then to be immersed in the solution so as to be well covered by it and supported in that position; the connections to the rest of the circuit are then to be made.

Contact is to be made at the key, noting the time. The current is to be allowed to pass for not less than half an hour, and the time of breaking contact observed.

The solution is now to be removed from the bowl and the deposit washed with distilled water and left to soak for at least six hours. It is then to be rinsed successively with distilled water and absolute alcohol and dried in a hot-air bath at a temperature of about 160° C. After cooling in a desiccator it is to be weighed again. The gain in mass gives the silver deposited.

To find the time average of the current in amperes, this mass, expressed in grams, must be divided by the number of seconds during which the current has passed and by 0.001118.

In determining the constant of an instrument by this method the current should be kept as nearly uniform as possible and the readings

of the instrument observed at frequent intervals of time. These observations give a curve from which the reading corresponding to the mean current (time average of the current) can be found. The current, as calculated from the voltameter results, corresponds to this reading.

The current used in this experiment must be obtained from a battery and not from a dynamo, especially when the instrument to be calibrated is an electrodynamometer.

SPECIFICATION B.—*The volt.*

Definition and properties of the cell.—The cell has for its positive electrode, mercury, and for its negative electrode, amalgamated zinc; the electrolyte consists of a saturated solution of zinc sulphate and mercurous sulphate. The electromotive force is 1.434 volts at 15° C., and, between 10° C. and 25° C., by the increase of 1° C. in temperature, the electromotive force decreases by .00115 of a volt.

(*1*) *Preparation of the mercury.*—To secure purity it should be first treated with acid in the usual manner and subsequently distilled in vacuo.

2. *Preparation of the zinc amalgam.*—The zinc designated in commerce as "commercially pure" can be used without further preparation. For the preparation of the amalgam one part by weight of zinc is to be added to nine parts by weight of mercury, and both are to be heated in a porcelain dish at 100° C., with moderate stirring until the zinc has been fully dissolved in the mercury.

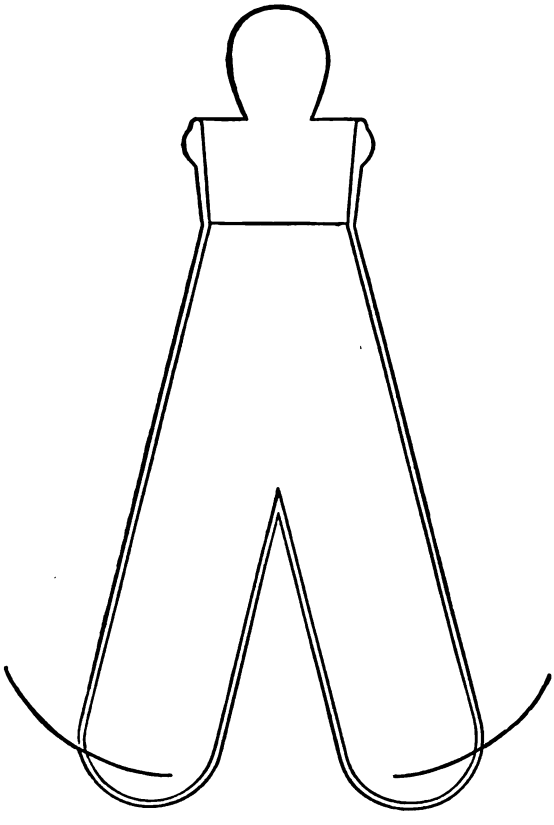
3. *Preparation of the mercurous sulphate.*—Take mercurous sulphate, purchased as pure, mix with it a small quantity of pure mercury, and wash the whole thoroughly with cold distilled water by agitation in a bottle; drain off the water and repeat the process at least twice. After the last washing, drain off as much of the water as possible. (For further details of purification, see Note A.)

4. *Preparation of the zinc sulphate solution.*—Prepare a neutral saturated solution of pure recrystallized zinc sulphate, free from iron, by mixing distilled water with nearly twice its weight of crystals of pure zinc sulphate and adding zinc oxide in the proportion of about 2 per cent by weight of the zinc sulphate crystals to neutralize any free acid. The crystals should be dissolved with the aid of gentle heat, but the temperature to which the solution is raised must not exceed 30° C. Mercurous sulphate, treated as described in 3, shall be added in the proportion of about 12 per cent by weight of the zinc sulphate crystals to neutralize the free zinc oxide remaining, and then the solution filtered, while still warm, into a stock bottle. Crystals should form as it cools.

5. *Preparation of the mercurous sulphate and zinc sulphate paste.*—For making the paste, two or three parts by weight of mercurous sulphate are to be added to one by weight of mercury. If the sulphate be dry, it is to be mixed with a paste consisting of zinc sulphate crystals and a concentrated zinc sulphate solution, so that the whole constitutes a

stiff mass, which is permeated throughout by zinc sulphate crystals and globules of mercury. If the sulphate, however, be moist, only zinc sulphate crystals are to be added; care must, however, be taken that these occur in excess and are not dissolved after continued standing. The mercury must, in this case also, permeate the paste in little globules. It is advantageous to crush the zinc sulphate crystals before using, since the paste can then be better manipulated.

To set up the cell.—The containing glass vessel, represented in the accompanying figure, shall consist of two limbs closed at bottom and joined above to a common neck fitted with a ground glass stopper.



The diameter of the limbs should be at least 2 cms., and their length at least 3 cms. The neck should not be less than 1.5 cms. in diameter. At the bottom of each limb a platinum wire of about 0.4 mm. diameter is sealed through the glass.

To set up the cell, place in one limb pure mercury, and in the other hot liquid amalgam, containing 90 parts mercury and 10 parts zinc. The platinum wires at the bottom must be completely covered by the mercury and the amalgam, respectively. On the mercury place a layer 1 cm. thick of the zinc and mercurous sulphate paste described in 5. Both this paste and the zinc amalgam must then be covered with

a layer of the neutral zinc sulphate crystals 1 cm. thick. The whole vessel must then be filled with the saturated zinc sulphate solution, and the stopper inserted so that it shall just touch it, leaving, however, a small bubble to guard against breakage when the temperature rises.

Before finally inserting the glass stopper it is to be brushed round its upper edge with a strong alcoholic solution of shellac and pressed firmly in place. (For details of filling the cell, see Note B.)

NOTES TO THE SPECIFICATIONS.

(A) *The mercurous sulphate.*—The treatment of the mercurous sulphate has for its object the removal of any mercuric sulphate which is often present as an impurity.

Mercuric sulphate decomposes in the presence of water into an acid and a basic sulphate. The latter is a yellow substance—turpeth mineral—practically insoluble in water; its presence, at any rate in moderate quantities, has no effect on the cell. If, however, it be formed, the acid sulphate is also formed. This is soluble in water, and the acid produced affects the electromotive force. The object of the washings is to dissolve and remove this acid sulphate, and for this purpose the three washings described in the specification will suffice in nearly all cases. If, however, much of the turpeth mineral be formed, it shows that there is a great deal of the acid sulphate present, and it will then be wiser to obtain a fresh sample of mercurous sulphate, rather than to try by repeated washings to get rid of all the acid.

The free mercury helps in the process of removing the acid, for the acid mercuric sulphate attacks it, forming mercurous sulphate.

Pure mercurous sulphate, when quite free from acid, shows on repeated washing a faint yellow tinge, which is due to the formation of a basic mercurous salt distinct from the turpeth mineral, or basic mercuric sulphate. The appearance of this primrose yellow tint may be taken as an indication that all the acid has been removed; the washing may with advantage be continued until this tint appears.

(B) *Filling the cell.*—After thoroughly cleaning and drying the glass vessel, place it in a hot-water bath. Then pass through the neck of the vessel a thin glass tube reaching to the bottom to serve for the introduction of the amalgam. This tube should be as large as the glass vessel will admit. It serves to protect the upper part of the cell from being soiled with the amalgam. To fill in the amalgam, a clean dropping tube about 10 cm. long, drawn out to a fine point, should be used. Its lower end is brought under the surface of the amalgam heated in a porcelain dish, and some of the amalgam is drawn into the tube by means of the rubber bulb. The point is then quickly cleaned of dross with filter paper and is passed through the wider tube to the bottom and emptied by pressing the bulb. The point of the tube must be so fine that the amalgam will come out only on squeezing the bulb. This process is repeated until the limb contains the desired quantity of the amalgam. The vessel is then removed from the water bath. After cooling, the

amalgam must adhere to the glass and must show a clean surface with a metallic luster.

For insertion of the mercury, a dropping tube with a long stem will be found convenient. The paste may be poured in through a wide tube reaching nearly down to the mercury and having a funnel-shaped top. If the paste does not move down freely, it may be pushed down with a small glass rod. The paste and the amalgam are then both covered with the zinc-sulphate crystals before the concentrated zinc-sulphate solution is poured in. This should be added through a small funnel, so as to leave the neck of the vessel clean and dry.

For convenience and security in handling, the cell may be mounted in a suitable case, so as to be at all times open to inspection.

In using the cell, sudden variations of temperature should, as far as possible, be avoided, since the changes in electromotive force lag behind those of temperature.

Respectfully submitted.

HENRY A. ROWLAND, *Chairman*,
HENRY L. ABBOT,
GEORGE F. BARKER,
CHARLES S. HASTINGS,
ALBERT A. MICHELSON,
JOHN TROWBRIDGE,
CARL BARUS,
Committee.

The report containing the above specifications was accepted and unanimously adopted by the Academy.

It was voted unanimously that the National Academy of Sciences, in accordance with section 2 of the act of Congress of July 12, 1894, entitled "An act to define and establish the units of electrical measure," does hereby prescribe the above specifications of details necessary for the practical application of the definitions of the ampere and volt called for by said act.

It was also voted unanimously that these specifications be published by the sending, by the president, of a copy of the same to each House of Congress and to the Secretary of State, with the request to the latter that they be issued by the State Department; and, further, by the printing by the home secretary of the Academy of a suitable number of copies for public distribution.

No further business was transacted, and the Academy adjourned to meet in Washington April 16, 1895.

ANNUAL MEETING.

[Held in Washington April 16 to 19, 1895.]

The session was held in the National Museum, the president, Prof. O. C. Marsh, presiding.

The following members were present during the session: Abbe, Abbot, Agassiz, Barker, Barus, Billings, Boss, Chandler (C. F.),

Chandler (S. C.), Chittenden, Comstock, Cope, Gibbs (W.), Gilbert, Gill, Goode, Gould, Hague, Hall (A.), Hastings, Hill (G. W.), Marsh, Mendenhall, Michelson, Mitchell (S. W.), Morse, Newcomb, Powell, Remsen, Rowand, Walker, White. Thirty-two members were present in all.

The president made a brief oral report. The home secretary submitted the following report for the past year:

HOME SECRETARY'S REPORT.

The general work of the past year has gone on as usual. The sixth volume of the memoirs of the Academy was finished and distributed in December, 1894. The annual reports for 1893 and 1894 have been printed during the present year and have been sent to members. The seventh volume of memoirs is now in the hands of the Public Printer. The contracts for the illustrations have been made and the printing will begin soon. The printing of the memoirs of the Academy and the annual reports have been ordered by act of Congress, so that the former delays will be avoided in future. The manuscript of Part III of the Proceedings of the Academy has been prepared and is ready for printing. This part will complete the first volume and brings the account of the Academy up to 1895. The Academy is much indebted to the Smithsonian Institution for the storage of its books and for sending out its publications. As the Institution needed the rooms occupied by the Academy, it was necessary to remove the books and records, and a division of books was made according to countries. The books are now packed away in 49 boxes, which are marked on the outside with the names of the countries sending the books.

The report of the treasurer was presented, and here follows:

TREASURER'S REPORT.

WASHINGTON, D. C., *April 16, 1895.*

To the PRESIDENT NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 16, 1895:

Income.	General fund.	Bache fund.	Watson fund.	Draper fund.	Smith fund.	Gibbs fund.
Balance from Apr. 17, 1894	$510.59	$3,818.89	$595.77	$1,357.05	$2,021.18	.....
Invested income	*a* 500.00	.....	*a* 1,500.00 *b* 826.83 *c* 500.00 *d* 1,000.00	.....	*e* 506.57	.....
Interest received, 1894-95	18.36	2,749.76	1,132.22	363.20	444.40	$133.06
Received from members' dues	420.00	.....	.....	.....	.....	.....
Total to account for	1,448.85	6,568.65	5,564.82	1,720.25	3,062.15	133.06

a District of Columbia 3.65 per cent bonds.
b Earnshaw loan, 6 per cent.
c Cosmos Club bonds, second series, 5 per cent.
d Walter loan, 5½ per cent.
e Webb loan, 5 per cent.

Income.	General fund.	Bache fund.	Watson fund.	Draper fund.	Smith fund.	Gibbs fund.
Disbursed in 1894–95	$538.86	$2,248.48	$680.24	$17.53	$2,900.50	$133.66
Invested income 1894–95			a 400.00 b 200.00	a 600.00 c 400.00 b 300.00		
Balance:						
Cash	409.99	4,320.17	447.75	402.72	456.08	
Bonds and loans	a 500.00		d 1,500.00 e 826.83 f 500.00 h 1,000.00		g 596.57	
Total accounted for	1,448.85	6,568.65	5,554.82	1,720.25	3,062.15	133.66
Available balance less obligations	409.99	3,120.17	447.75	402.72	456.08	

a M. F. Morris loan, 5 per cent.
b D. C. Wharton Smith loan, 5 per cent.
c Simpson loan, 5 per cent.
d District of Columbia 3.65 per cent bonds.
e Earnshaw loan, 6 per cent.
f Cosmos Club bond, second series, 5 per cent.
g Webb loan, 5 per cent.
h Walter loan, 5½ per cent

Statement of investments, showing the proportion belonging to each fund.

Investments.	Rate.	General fund.	Bache fund.	Watson fund.	Draper fund.	Smith fund.	Gibbs fund.
CAPITAL FUND.							
	Per ct.						
Dubant loan	5		$9,096.00	$1,344.00		$1,560.00	
Cosmos Club bonds, first series	5			500.00			
Gineai loan	6			1,000.00			
Dunlop loan	5		8,530.00	3,920.00		4,550.00	
Holtzman loan	5		10,000.00				
Williamson and Kimmell	5		4,596.00	670.83		1,560.00	$2,673.17
Mockbee loan	5		5,000.00				
Cosmos Club bonds, second series	5			500.00			
Earnshaw loan	6			173.17			
Lowenthal loan	5		3,000.00				
Webb loan	5		1,403.43				
Walter loan	5½		1,272.37	558.88	$6,603.75	565.00	
Simpson loan	5		600.00				
Stevens loan	6		4,000.00				
Newlands (trustee) loan	5		2,000.00				
D. C. Wharton Smith loan	5		1,500.00				
Harvey loan	5			5,000.00			
Willoughby loan	5			5,000.00			
Total			50,997.80	18,666.88	6,603.75	8,235.00	2,673.17
INVESTED INCOME.							
District of Columbia bonds	3.65	$500.00		1,500.00			
Earnshaw loan	6			826.83			
Cosmos Club bonds, first series	5			500.00			
Webb loan	5					596.57	
Walter loan	5½			1,000.00			
Morris loan	5			400.00	600.00		
Simpson loan	5				400.00		
D. C. Wharton Smith loan	5			200.00	300.00		
Total		500.00		4,426.83	1,300.00	596.57	

Total capital fund	$87,176.60
Total invested income	6,823.40
Aggregate	94,000.00

Cash balances remaining on hand at examination of treasurer's accounts April 17, 1895.

Finds.	Income from investments, etc.
CAPITAL.	
General fund	$409.99
Bache fund	4,320.17
Watson fund	447.75
Draper fund	402.72
J. Lawrence Smith fund	456.08
Wolcott Gibbs fund	.....
Total	6,036.71
INVESTED INCOME.	
General fund, District of Columbia bonds, 3.65	500.00
Watson fund:	
District of Columbia bonds, 3.65	1,500.00
Earnshaw	826.83
Cosmos Club	1,000.00
Walter	1,000.00
Morris	400.00
Wharton Smith	200.00
Draper fund:	
Morris	600.00
Simpson	400.00
Wharton Smith	300.00
Smith fund (Webb)	596.57

The cost of renewal of the treasurer's bond for the year ending June 30, 1895, namely, $100, has been distributed pro rata to the several funds of the Academy, as in the year preceding.

Very respectfully, your obedient servant,

J. S. BILLINGS,

Treasurer National Academy of Sciences.

Report on the general and special funds.

GENERAL FUND.

CASH.

Dr.					Cr.
1894.			1894.		
Apr. 17	To balance brought forward	$510.59	Apr. 26	By C. W. Shoemaker, recording secretary, 1893-94	$25.00
	Cash from members' dues, viz:		Apr. 26	F. W. Stone, bookkeeper	40.00
	For 1893, 8 at $5	40.00	May 9	Judd & Detweiler, printing	46.25
	For 1894, 74 at $5	370.00	May 16	Alf. Klakring, engrossing	18.00
	For 1895, 2 at $5	10.00	May 25	Judd & Detweiler, printing	35.00
	Interest on District of Columbia 3.65 bonds	18.26	June 12	Jno. Croghan, lunches (April meeting)	100.00
			June 15	Judd & Detweiler, printing	8.20
			June 20	J. Sprigg Poole, Fidelity and Deposit Co. (bond)	5.00
			July 5	Samuel Cross, rent of safe	15.00
			Oct. 1	Judd & Detweiler, printing	3.25
			Oct. 15	F. W. Stone, postage, etc	5.17
			Nov. 15	Tuttle, Morehouse & Taylor, printing	9.25
			1895.		
			Jan. 31	Judd & Detweiler, printing	2.30
			Feb. 5	C. W. Shoemaker, compiling	20.00
			Feb. 26	F. V. Berry, services, packing, etc	91.92
			Mar. 6	Judd & Detweiler, printing	21.45
			Mar. 20	Judd & Detweiler, printing	8.60
			Mar. 28	A. Hall, secretary, expenses	15.47
			Apr. 5	O. C. Marsh, electrical commission	15.00
			Apr. 5	H. A. Rowland, electrical commission	54.00
			Apr. 17	Balance	409.99
		948.85			948.85

INVESTED INCOME.

			1895.		
	District of Columbia 3.65 bonds	$500.00	Apr. 17	Income fund remaining invested	$500.00
		500.00			500.00

List of securities found in the box of the National Academy of Sciences, Washington Safe Deposit Company, April 15, 1895.

Land warrant, No. 62749, for 160 acres of land, southeast quarter section 11, township 34, range 23, Booneville, Mo. (This deed has not yet been transferred to the name of the Academy.)

Will of the late John L. Le Conte.

Deed of trust, Mary Ann Palmer Draper, giving $6,000 to the Academy as a special fund.

Deed of trust, Mrs. Sarah Julia Smith, giving $8,000 to the Academy as a special fund.

An agreement with the Pennsylvania Company for insurance on lives and granting annuities, as to the final disposition of the "Joseph Henry" fund, $40,000.

District of Columbia 3.65 bonds: No. 3435, $1,000; No. 3436, $1,000—$2,000.

Cosmos Club bonds, first series, Nos. 141 to 145, at $100, $500; Nos. 75 to 79, at $100, $500; second series, No. 260, $500.

Certificate of Riggs & Co., bankers, that they hold on deposit for collection, notes amounting to $88,500.

Guarantee bond, treasurer National Academy of Sciences, and renewal.

REPORT OF THE COMMITTEE ON SECURITIES.

WASHINGTON, *April 15, 1895.*

SIR: The committee appointed by you to examine the securities of the Academy held by the treasurer, Dr. J. S. Billings, have this day performed this duty and have signed duplicate reports, one of which is in the hands of the treasurer and the other is submitted herewith, showing what securities we find in the box of the National Academy of Sciences at the office of the Washington Safe Deposit Company.

Very respectfully, yours,

CLEVELAND ABBE,
Chairman of the Committee.

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

Bache fund, 1894–95.

CASH.

Dr.							Cr.
1894.				1894.			
Apr. 16	To balance brought forward		$3,818.89	June 6	By A. W. Peckham	$80.00	
Apr. 16	interest, Dunlop loan, 5 per cent	$213.25		June 6	A. C. Abbott	4.29	
May 2	interest, Lowenthal loan	75.00		June 29	J. Sprigg Poole (Fidelity and Deposit Co., treasurer's bond)	51.53	
May 9	interest, Clark et al. loan	187.50		July 11	A. W. Peckham	40.00	
May 9	interest, Holtzman loan	250.00		Aug. 1	A. W. Peckham	28.00	
May 14	interest, Mockbee loan	125.00		Oct. 1	C. L. Minot	250.00	
May 19	interest, Webb loan	35.09		Nov. 2	A. W. Peckham	46.00	
May 29	interest, Williamson and Kimmel loan	114.90		Dec. 4	A. W. Peckham	40.00	
Aug. 30	interest, Walter loan	34.99		Jan. 4	A. W. Peckham	40.00	
Sept. 28	interest, Dubant loan	227.40		Feb. 26	A. W. Peckham	40.00	
Oct. 15	interest, Dunlop loan	213.25		Mar. 14	Riggs & Co., accrued interest on Simpson loan	6.17	
Nov. 1	interest, Lowenthal loan	75.00		Apr. 2	J. S. Billings, balance of appropriation of May 1, 1893	1,072.13	
Nov. 1	interest, Holtzman loan	250.00		Apr. 9	Lewis Boss	500.00	
Nov. 12	interest, Mockbee loan	125.00		Apr. 9	Riggs & Co., accrued interest on Stevens loan	4.66	
Nov. 14	interest, Clark et al. loan	187.50		Apr. 9	Riggs & Co., accrued interest on Newlands loan	26.11	
Nov. 19	interest, Webb loan	35.09		Apr. 9	Riggs & Co., accrued interest on D. C. Wharton Smith loan	19.59	
1895.				Apr. 17			$2,248.48
Jan. 7	interest, Williamson and Kimmel loan	114.90			balance		4,320.17
Mar. 8	interest, Clark et al. loan	187.50					
Mar. 13	interest, Walter loan	34.99					
Mar. 19	interest, Philadelphia bonds loan	36.00					
Mar. 27	interest, Dubant loan	227.40					
			2,749.76				
			6,568.65				6,568.65

OUTSTANDING OBLIGATIONS.

1895.				1892.*			
Apr. 17	Cash balance		$4,320.17	Mar. 1	By Dr. C. T. Minot (balance)	$250.00	
				1893.*			
				Nov. 21	Prof. W. K. Brooks (balance)	400.00	
				1894.*			
				Nov. 12	Prof. S. C. Chandler (balance)	250.00	
				Dec. 26	Prof. S. Newcomb	300.00	
				1895.*			
				Apr. 17	Available balance		3,120.17
			4,320.17				4,320.17

* Appropriations.

Watson fund, 1894–95.

CASH.

Dr.				Cr.			
1894.				1894.			
Apr. 17	To balance brought forward		$595.77	June 29	By J. Sprigg Poole (Fidelity Deposit Co., treasurer's bond)	$23.83	
Apr. 16	interest, Dunlap loan, 5 per cent	$98.00		Aug. 6	Riggs & Co., accrued interest on Harvey loan	25.00	
June 13	interest, Cosmos Club bonds (first series), 5 per cent	25.00		1895.			
May 27	interest, Williamson and Kimmel loan, 5 per cent	16.77		Jan. 9	Riggs & Co., accrued interest, Willoughby loan	21.52	
July 30	interest, Ginesi loan, 6 per cent	30.00		Jan. 9	Riggs & Co., accrued interest on Morris loan	1.54	
Aug. 4	interest, Barber loan, 5 per cent	250.00		Jan. 9	Riggs & Co., on Morris loan (investment)	400.00	
Aug. 30	interest, Walter loan, 5½ per cent	15.37		Apr. 3	Tiffany & Co., for dies	890.00	
Aug. 30	interest, Walter loan (income), 5½ per cent	27.50		Apr. 3	Tiffany & Co., medal	110.00	
Sept. 28	interest, Dubant loan, 5 per cent	33.60		Apr. 3	United States Express Co., freight	.75	
Sept. 29	interest, Earnshawe loan, 6 per cent	30.00		Apr. 9	Riggs & Co. (gold coin) prize	100.00	
Oct. 16	interest, District of Columbia bonds, 3.65 per cent	27.37		Apr. 9	F. W. Stone (purse for coin)	5.00	
Oct. 16	interest, Cosmos Club bonds (second series), 5 per cent	12.50		Apr. 9	Riggs & Co. (Smith loan), investment	200.00	
Oct. 15	interest, Dunlop loan, 5 per cent	98.00		Apr. 9	Riggs & Co. (Smith loan), accrued interest	2.61	
Dec. 3	interest, Cosmos Club (first series), 5 per cent	25.00					$1,280.24
1895.							
Jan. 7	interest, Williamson and Kimmel loan, 5 per cent.	16.77					
1894.							
Dec. 29	interest, Harvey loan, 5 per cent	125.00					
1895.							
Jan. 3	interest, Willoughby loan, 5 per cent	125.00					
Jan. 7	interest, Ginesi loan, 6 per cent	30.00					
Feb. 2	interest, District of Columbia bonds, 3.65 per cent.	27.37					
Mar. 13	interest, Walter loan, 5½ per cent	15.37					
Mar. 13	interest, Walter loan (income), 5½ per cent	27.50					
Apr. 3	interest, Cosmos Club bonds (second series), 5 per cent	12.50					
Mar. 27	interest, Dubant loan, 5 per cent	33.60					
Mar. 29	interest, Earnshawe loan, 6 per cent	30.00					
			1,132.22	1895.			
			1,727.99	Apr. 17	Available balance		447.75
							1,727.99
1891.							
Apr. 15	interest, District of Columbia bonds, 3.65 per cent.	1,500.00					
1892.							
Oct. 5	interest, Earnshawe loan, 6 per cent	826.83					
1893.							
Aug. 17	interest, Cosmos Club bonds (first series), 5 per cent	500.00					
1894.							
Mar. 5	interest, Walter loan, 5½ per cent	1,000.00					
1895.							
Jan. 9	interest, Morris loan, 5 per cent	400.00					
Apr. 9	interest, D. C. Wharton Smith loan, 5 per cent	200.00					
			4,426.83	1895.			
			4,426.83	Apr. 17	Total income invested		4,426.83
							4,426.83

Draper fund, 1894–95.

Dr.		CASH.			Cr.
1894.			1894.		
Apr. 17	To balance brought forward	$1,357.05	June 29	By J. Sprigg Poole (Fidelity Deposit Co., treasurer's bond)	$7.15
Aug. 30	interest, Walter loan, 5½ per cent	181.60	1895.		
1895.			Jan. 9	Riggs & Co., Morris loan and interest	602.36
Mar. 13	interest, Walter loan, 5½ per cent	181.60	Mar. 14	Riggs & Co., Simpson loan and interest	404.11
			Apr. 9	Riggs & Co., Smith loan and interest	303.91
			Apr. 17	balance	402.72
		1,720.25			1,720.25

Income invested, $1,300.

J. Lawrence Smith fund, 1894–95.

Dr.					Cr.
1894.			1894.		
Apr. 17	To balance brought forward	$2,021.18	May 9	By board of management, Yale Observatory	$2,000.00
Apr. 16	interest, Dunlop loan, 5 per cent	113.75	June 29	J. Sprigg Poole (Fidelity Deposit Co., treasurer's bond)	9.50
May 19	interest, Webb loan, 5 per cent	14.91			
May 27	interest, Williamson and Kimmel loan, 5 per cent	39.00			
Aug. 30	interest, Walter loan, 5½ per cent	15.54			
Sept. 28	interest, Dubant loan, 5 per cent	39.00			
Oct. 15	interest, Dunlop loan, 5 per cent	113.75			
Nov. 19	interest, Webb loan, 5 per cent	14.91			
1895.					
Jan. 7	interest, Williamson and Kimmel loan, 5 per cent	39.00			
Mar. 13	interest, Walter loan 5½ per cent	15.54	1895.		
Mar. 27	interest, Dubant loan, 5 per cent	39.00	Apr. 17	balance	456.08
		2,465.58			2,465.58

Invested income, total, $596.57.

The Wolcott Gibbs fund, 1894–95.

Dr.		CASH.			Cr.
1894.			1894.		
May 27	To interest on Williamson and Kimmel loan	$66.83	June 13	By Wolcott Gibbs, appropriation June 15, 1892	$66.83
Nov. 1	interest on Williamson and Kimmel loan	66.83	June 29	J. Sprigg Poole (Fidelity Deposit Co., treasurer's bond)	3.00
			Nov. 22	Wolcott Gibbs, appropriation June 15, 1892	63.83
		133.66			133.66

WASHINGTON, D. C., *April 16, 1895.*

The investments, etc., from the income of the Draper fund during the year 1894–95 amount to $1,317.53, less $10.38 "accrued interest," which will be returned upon the first payment of interest on notes; $1,307.15.

WASHINGTON, D. C., *April 17, 1895.*

The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances correspond to the vouchers, books, and accounts of the treasurer, and are found correct.

IRA REMSEN.
THEO. GILL.
G. W. HILL.

PAPERS READ AT THE ANNUAL MEETING.

On Soil Bacteria. M. P. Ravenel.

On the Composition of Expired Air and its Effect upon Animal Life. J. S. Billings.

Notes on the Florida Reef. A. Agassiz.

On the Secular Motion of a Free Magnetic Needle. L. A. Bauer.

On Colour Relations of Atoms, Ions, and Molecules. M. Carey Lea.

The Progress of the Publications on the Expedition of 1891 of the United States Fish Commission Steamer *Albatross*, Lieut. Commander Z. L. Tanner, commanding. A. Agassiz.

On Some Variations of the Genus Eucope. A. Agassiz and W. M. Woodworth.

Mechanical Interpretation of the Variations of Latitude. R. S. Woodward.

Biographical Memoirs of Lewis M. Rutherford. B. A. Gould.

*On a New Determination of the Nutation Constant and Some Allied Topics. S. C. Chandler.

*A Linkage Showing the Laws of the Refraction of Light. A. M. Mayer.

Systematic Catalogue of European Fishes. T. Gill.

The Extinct Cetacea of North America. E. D. Cope.

On the Application of a Percentage Method in the Study of the Distribution of Oceanic Fishes: A. Definition of Eleven Faunas and Two Subfaunas of Deep-Sea Fishes; B. The Relationship and Origin of the Carribeo-Mexican and Mediterranean Subfaunas. G. Brown Goode.

On the Two Isomeric Chlorides of Ortho-Sulpho-Benzoic Acid. Ira Remsen.

On Some Compounds Containing Two Halogen Atoms in Combination with Nitrogen. Ira Remsen.

Relation of Jupiter's Orbit to the Mean Plane of Four Hundred and One Minor Planet Orbits. H. A. Newton.

Orbit of Miss Mitchell's Comet, 1847, VI. H. A. Newton.

The papers marked with an asterisk (*) were read by title only.

ELECTIONS.

The terms of office of the president and home secretary of the Academy having expired, the Academy proceeded to the election of officers to fill the vacancies. Mr. Marsh declined to be a candidate for reelection. Mr. Wolcott Gibbs was then elected president, and Mr. Asaph Hall home secretary.

The office of foreign secretary becoming vacant in consequence of the election of Mr. Gibbs as president, Mr. A. Agassiz was elected. The following-named six additional members of the council were then elected: Messrs. Marsh, Remsen, Newcomb, Goodale, Gould, and Brush.

The following resolution was then passed by a unanimous vote:

"That the thanks of the Academy be tendered to the retiring president for the zeal and ability with which he has administered in succession the offices of vice-president and president of the Academy during a period of seventeen years."

The Academy, without a formal vote, acquiesced in the opinion of the council that the present officers should retain office until the end of the session at which the election of their successors occurs. The incoming and retiring presidents made brief addresses.

ELECTION OF NEW MEMBERS.

Four new members of the Academy were elected at this session with the usual form. They were William H. Welsh, William L. Elkin, Charles S. Sargent, and Charles O. Whitman.

Three foreign associates were also elected, namely, Rudolph Leuckart, Julius von Sachs, and Sophus Lie.

As it has not been the custom of the president of the Academy to be a member of any of the standing committees, the president, after consultation with the president-elect, made the following appointments: Mr. Michelson to be a member of the committee on weights and measures; Mr. Trowbridge to be a member of the committee on the Henry Draper fund; Mr. S. W. Johnson to be a member of the committee on the J. Lawrence Smith fund; Mr. Agassiz to be a member of the committee on the election of foreign associates, and Mr. S. Weir Mitchell to be a member of the last-named committee in place of Mr. Dana, deceased.

During the year the Academy lost by death Mr. James D. Dana and Mr. James E. Oliver, members, and Mr. Huxley, Mr. Cayley, and Mr. Pasteur, foreign associates.

The president appointed Mr. E. S. Dana to prepare a biographical notice of Mr. James D. Dana, and Mr. G. W. Hill to prepare a notice of Mr. James E. Oliver.

AMENDMENT TO THE CONSTITUTION.

The following amendment to the constitution was passed at this session, and forms Article IV, section 10:

"Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the Academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall be no longer a member of the Academy, and his name shall be dropped from the roll."

REPORTS FROM TRUST FUNDS.

Mr. W. Gibbs reported that during the year 1895 the following appropriations were made from the Bache fund: An appropriation of $1,200 to Dr. J. S. Billings to carry on investigations of the conditions affecting the variability of bacteria; an appropriation of $1,000 to Henry A. Rowland to carry on his investigation of solar and metallic spectra.

Report of the trustees of the Watson fund on the award of the Watson medal to Mr. S. C. Chandler.

On the recommendation of the board of trustees of the Watson fund the Academy last year unanimously awarded the Watson medal to Seth C. Chandler, of Cambridge, Mass., for his investigations relative to variable stars, for his discovery of the period of variation of terrestrial latitudes, and for his researches on the laws of that variation. It is the pleasant duty of the trustees to set forth the grounds on which this award was recommended.

It is a well-known result of the laws of dynamics relating to the rotation of a rigid body—as the earth is assumed to be—upon its axis that the pole of the earth may be determined in two ways. Our globe being a spheroid flattened at the poles and protuberant at the equator has a certain axis passing between the points of greatest flattening. This axis has no direct connection with the rotation of the earth; it would exist if the latter, retaining its present form, did not rotate at all. It is called the axis of figure, being determined altogether by the shape of the earth.

But the earth has also an axis around which it rotates. Now, assuming the earth to be a rigid solid, there is no necessity that the axis of rotation should correspond with that of the axis of figure just described. We could take a solid body, pass an axis through it in any direction, and make it rotate on that axis.

It was shown by Euler more than a century ago that if a solid body rotated on an axis different from that of figure the position of the axis of rotation in the body would be subject to a slow change, consisting in a constant revolution round the axis of figure. Were this body the earth the latitude of a place as determined by astronomical observa-

tion would change in the same way. The time of one revolution of the pole would depend upon the figure of the earth. The flattening of the earth is such that were it a perfectly rigid body the time of revolution would be about 305 days; that is to say, the North Pole would make its circuit in a period of 305 days.

There being no necessity that the two poles should coincide, the question was naturally raised whether perhaps there might not actually be such a difference of the two poles and in consequence a change of latitude of every place on the earth's surface having a period of 305 days.

The first to investigate this question with all the refinement of modern astronomy was C. A. F. Peters, who, half a century ago, was an assistant at the Pulkowa Observatory. In his classic paper on the parallax of the fixed stars one section is devoted to the question of the variability of the latitude in a period of 304 days, which, according to the then accepted value of the flattening of the earth, would be the time of a revolution of the poles. He found a coefficient of 0.079″, with a probable error of 0.017″. This result was so extremely minute that it might have arisen from unavoidable sources of error, and the conclusion therefore reached was that if there was any such separation of the two poles it was too small to be certainly detected by the most refined observations.

In 1862 our late fellow-member, Professor Hubbard, of the Naval Observatory, commenced a series of observations with the prime vertical transit of that institution which would be available for the same research. They were interrupted after a little more than a year by his untimely death, but were continued four years longer by his successor. The result was the same as that reached by Peters and Nyrén; no change during a period of 305 days could be detected.

In 1873 the question was investigated by Nyrén in connection with a longer series of observations on the latitude of the Pulkowa Observatory. The results were somewhat discordant and the only conclusion that could be drawn from them was that the variation could not be certainly detected by these most refined observations.

Ten years later Nyrén repeated the determination in connection with his observations for the determination of the constant of aberration. These observations, made with the prime vertical transit, were carried through with the minutest attention and the utmost care to avoid every conceivable source of error. Curious discordances were nevertheless found in the results for the constant of aberration. In 1885 Küstner showed that they could be accounted for by supposing a change going on in the latitude. But nothing could be inferred respecting the law or the cause of the change.

As a result of these investigations the coincidence of the earth's axes of rotation and of figure has until within a very few years been assumed by astronomers as a practically established fact, and all their methods of observation have rested upon the idea of absolute coincidence. This

confidence has not been disturbed until within a few years, when the question has been reopened. But it has now apparently been settled upon a new and firmly established basis.

Dr. Chandler's work upon this subject began with observations made by him in 1884–85, using a novel form of astronomical instrument of his own invention. These observations, continued uninterruptedly for thirteen months, revealed a progressive change of a pronounced periodical character in the instrumental values of the latitude. In publishing these results in 1885 he announced his intention to continue the research throughout the remainder of that year. Yet circumstances prevented him from carrying out this intention at that time, and he did not resume his examination of the subject until six years later. Meanwhile Dr. Küstner, at the Observatory of Berlin, in 1888, published a memoir on the Constant of Aberration as deduced by him from a series of observations also made in 1884–85, simultaneously with Chandler's series, which brought to light anomalies of an entirely analogous character.

Küstner's series was not continuous enough to show the periodic nature of the phenomenon; but, by an exhaustive examination of the possible subjective sources of error, he clearly demonstrated that it was no longer permissible to retain the hypothesis of an invariable position of the pole, and he recommended that properly organized observations at various places be instituted to settle the question definitely. It was doubtless this work of Küstner's which compelled the attention of astronomers to the subject. As a result, by the cooperation of three German observatories under the auspices of the International Geodetic Association, and the independent action of that at Pulkowa, the fact of the variability of terrestrial latitudes was placed beyond question, and, by a corresponding series made at the Sandwich Islands, the further fact was established that the variable element is the position of the axis of rotation with respect to the earth's body, and not its position in space.

It was just before this point that a renewal of Chandler's connection with the problem began. The results are published in a series of eighteen papers in the Astronomical Journal (1891–1894), exclusive of a series of five papers upon a topic closely related thereto and involving it, viz, the aberration-constant, which will be separately spoken of later. The keynote of these investigations, and the undoubted cause of the success which has attended them, lies in the fact that at the outset he first recognized the necessity of deliberately disregarding all teachings of the adopted theory which had misled previous investigators, and of examining the facts by a purely inductive process, taking nothing for granted, and basing all conclusions strictly upon the observations themselves.

It is impossible to give here more than a bare statement of the principal results thus established, which we arrange in their natural order, and not in the historical order of their derivation:

1. The phenomenon is not a local or a regional, but a terrestrial

one; also it is a displacement of the earth's axial rotation with reference to the principal axis of inertia, and not of the direction of the former in space.

2. The axis of rotation, although fixed as regards its direction in space, performs a relative revolution about that of inertia in a period of 428 days. This motion is circular, with an average radius of about 14 feet, and its direction is from west to east.

3. Simultaneously with the above motion, the actual position of the principal axis of inertia on the earth's surface is in motion about a mean position, in a period of a year. Its direction is also from west to east, but is in an ellipse three or four times as long as broad, the major and minor axes being about 25 feet and 8 feet, respectively. The major axis is inclined at present by about 45° to the Greenwich meridian. The motion is central, obeying the law of proportionality of times to areas described by the radius vector about the center of the ellipse.

4. Both the radius and period in the circular 428-days' revolution are systematically variable, the former between about 8 feet and 18 feet, the latter between 423 and 434 days, in a long period of apparently about sixty-six years. In this inequality of motion the average angular velocity is attained when the size of the circle is least or greatest, and is least or greatest when the circle has its mean dimensions.

5. Similarly there are simultaneous changes in the apparent dimensions and velocity in the annual period which are complementary in their character to those in the 428-days' revolution; but whether they are the result of real changes in the form and dimensions of the ellipse, or the effect of an apsidal motion of long period, can not at present be determined from the observations available. All that can be said is that observations during five years show that the line of apsides is either fixed or, if variable, revolving only at a very slow rate.

6. Beside these two motions of relatively short period, there is distinct evidence of a third motion of rotation in a much longer term, probably not far from twelve years, with a radius of 10 or 15 feet, which reconciles similar indications of slow changes which had been pointed out by other investigators.*

The results thus established are the outcome of the examination of an immense number of observations, covering the whole interval since the era of refined practical astronomy began, and in fact practically exhaust the materials which may be drawn for this purpose from existing astronomical annals. The endeavor to make the discussion exhaustive in this respect made it necessary to completely reduce, from the original instrumental readings, extensive older series of observations.

It has, incidentally for example, rescued from almost complete oblivion the series of Pond, 1825–1836, and shown that work to be of a character which will compare favorably with the most refined observations made with the meridian instruments of the present day.

*A. J., xii, 178; xiii, 35, 36.

Intimately connected with the work on the variation of latitude are five additional papers containing a redetermination of the value of the aberration-constant from eight different series of observations at the Pulkowa Observatory, with the prime vertical transit and the vertical circle. The correct value of this fundamental element is one of the most important questions occupying the astronomy of the day.

VARIABLE STARS.

The subject of variable stars was erected into a distinct branch of astronomical science by Argelander, beginning in 1843, and occupied a large share of his activity and interest during a score of years. His classical labors were succeeded or overlapped by those of Schönfeld, who assumed the principal charge of the subject for another score of years, when his devotion to his great work of the Southern Durchmusterung, and later his failing health, left opportunity for other hands to take up and continue the work where they had left it.

Since the issue of Schönfeld's Second Catalogue the number of known variables has more than doubled, while the fund of observations pertaining to them has vastly increased. Chandler's work in this direction, besides the incidental work of observation and discovery which he has contributed to it, has involved the collection of all the data in astronomical history, their discussion, and the formulation of the elements of their light variations into numerical laws. The catalogues of 1888 and 1893, while filling a very moderate number of pages of print, are a crystallization of all the known facts. Especially may be mentioned the investigations of the inequalities in the periods of these bodies. While the number of these inequalities known in Schönfeld's time amounted to only about half a dozen, Chandler has detected their existence in about eighty other stars and has deduced the numerical laws in about fifty of them. This will indicate, in one direction only, how the labor of caring for these objects is increasing.

It would be unjust if, while alluding to these important researches, no mention were made of Mr. Chandler's ingenious and successful device of a new form of instrument for making that class of measurements of position which had previously been made by meridian instruments alone. Both the instrument and the method were novel. In the former, instead of a motion of rotation determined mechanically by the pivots of a horizontal axis, there was substituted one about a vertical axis determined by gravitative action of an instrument resting in mercury.

As to method, instead of a vertical plane passing through the pole, which is the fundamental plane of reference for meridian instruments, there was substituted a horizontal circle. The value possessed by such an entirely different method consists in substituting a totally different sort of observation, and hence a different set of the systematic errors to which all observations are liable; so that the combined results of

the two methods are likely to be freer from them than those obtained by an adherence to a single system of observation.

In a memoir of 222 pages Dr. Chandler developes the theory of the instrument and method mathematically, and gives the result of its practical use in observations made with it for a year, and directed to various astronomical problems.

Although not mentioned as forming any part of the grounds for the award of this medal, Dr. Chandler's important labors for many years upon cometary orbits are well known to astronomers. Casual mention may be especially made of his computations relative to the principal component of 1889 V and the action of Jupiter in 1886 upon it, which led to a complete transformation of its orbit; also to the definite determination of the relative orbits of the several components into which this comet became separated in consequence of that disturbance.

The trustees of the Watson fund feel that this brilliant series of investigations is preeminently deserving of the highest recognition which can be given by the National Academy, and have therefore not hesitated in recommending the award of the medal to Dr. Chandler.

S. NEWCOMB.
B. A. GOULD.
A. HALL.

Report of the Committee on the Barnard Medal to the National Academy of Sciences.

Your committee has held several conferences and has agreed unanimously upon the name to be presented to the National Academy for the award of the Barnard medal. The language of the bequest is very precise, and the committee has endeavored to comply specifically with its conditions.

The restrictions are contained in the following paragraph of Dr. Barnard's will:

> To such person, whether a citizen of the United States or of any other country, as shall, within the five years next preceding, have made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as, in the judgment of the National Academy of Sciences of the United States, shall be esteemed most worthy of such honor.

The committee was constrained to limit its consideration to work which either resulted in discovery, as distinguished from work, which, however comprehensive, novel, and brilliant, has not resulted in actual discovery, but in the invention and application of new apparatus or methods of investigation; or to some "novel application of science to purposes beneficial to the human race."

Acting upon all the suggestions received from members of the Academy and such other information as the members of the committee could secure, and acting in strict conformity to the specific conditions of the bequest, the committee herewith unanimously presents the name of Lord Rayleigh for the first award of the Barnard medal for his bril-

liant discovery of argon, which illustrates so completely the value of exact scientific methods in the investigation of the physical properties of matter. A copy of the bequest is attached to the report.

C. F. CHANDLER, *Chairman.*
LEWIS BOSS.
C. B. COMSTOCK.
E. S. DANA.
G. BROWN GOODE.

WASHINGTON, D. C., *April 18, 1895.*

EXTRACT FROM THE WILL OF THE LATE DR. F. A. P. BARNARD.

But of the income from this said fund I desire that so much as may be necessary shall be applied in the manner following: The trustees of Columbia College shall cause to be struck, with suitable devices, a medal of gold, nine-tenths fine, of the bullion value of not less than $200, to be styled "The Barnard medal for meritorious service to science," and shall publicly announce that a copy of the same will be awarded at the close of every quinquennial period, dating from the probate of this my last will and testament, to such person, whether a citizen of the United States or of any other country, as shall within the five years next preceding have made such discovery in physical or astronomical science or such novel application of science to purposes beneficial to the human race as in the judgment of the National Academy of Sciences of the United States shall be esteemed most worthy of such honor. And I make it my request that the said National Academy of Sciences shall charge itself with the duty of declaring to the trustees of Columbia College aforesaid, at the close of every term of five years, as above defined, the name of the person whom they judge worthy to receive such medal, with a statement of the reasons on which their judgment is founded; and that upon such declaration and nomination the trustees shall proceed to award the said medal, and shall transmit the same to the person entitled to receive it, accompanied by a diploma or certificate attesting the fact and the occasion of the award. But if the said National Academy of Sciences shall judge that during the five years preceding the date at which, as above provided, this award shall become due, no discovery in physical or astronomical science or no new application of scientific principles to useful purposes has been made worthy of the distinction proposed, then it is my wish and request the award shall be for that time omitted.

And I would further desire that the medal above described should bear, if it can be accomplished without interfering with the appropriate artistic device upon its obverse side, the motto, "Magna est veritas," and upon its reverse the motto, "Deo optimo maximo, gloria in excelsis."

RESOLUTIONS OF THE BOARD OF TRUSTEES OF COLUMBIA COLLEGE.

Resolved, That one such medal be awarded at commencement at the close of every *quinquennial period*, dating from the 17th of July, 1889, to such person, if any,

whether citizen of the United States or of any other country, as shall within the five years next preceding have made such discovery in physical or astronomical science or such novel application of science to purposes beneficial to the human race as in the judgment of the National Academy of Sciences of the United States shall be esteemed most worthy of such honor.

Resolved, That the clerk be instructed to transmit to the National Academy of Sciences a copy of that portion of the will of Dr. Barnard relating to "The Barnard medal for meritorious service to science," and to ascertain whether such Academy will charge itself with the duty of declaring to the trustees at the close of every term of five years the name of the person whom they judge worthy to receive such medal.

The first medal is to be awarded at commencement in 1895.

BUSINESS MEETING.

[Held in Philadelphia October 30, 1895.]

A business meeting of the Academy having been called by the council to consider the report of the president to Congress and such other business as might be presented, was held October 30. The president, Mr. Wolcott Gibbs, presided.

After the call of the roll the president presented an outline of his report to Congress for the year 1895. Upon the recommendation of the council the Academy authorized the president to present his report to Congress and to include in this report the proceedings of the present meeting, and also any Government business that may come before the Academy.

The president then read an address containing various suggestions relating to the work and organization of the Academy. The address was referred to the council.

The following resolutions, recommended by the council, were passed by a unanimous vote:

1. Whereas, since 1874, Prof. J. P. Lesley, as the director of the second geological survey of Pennsylvania, has, with the cooperation of a band of assistants, published 127 octavo volumes of reports, which will remain a monument of his scientific and literary activity:

Resolved, That the National Academy of Sciences, at a session held in Philadelphia on the 30th of October, 1895, while expressing their regret at the absence of their fellow-member, J. P. Lesley, wish at the same time to congratulate him on the successful completion of his reports on the geological survey of Pennsylvania, and further to express their appreciation of the services he has rendered to science in devoting his life to the interest of the survey, a task to which he has brought an unsurpassed knowledge of the geology of the State.

2. The Academy congratulate their fellow-member, Dr. John S. Billings, on the completion of his Catalogue of the Army Medical Library, and on the issue of the final sixteenth volume of this unequaled gift to the medical scholars of the world.

On recommendation of the council the following changes in the rules were then adopted:

The committee to whom was referred the question of revision of the

rules of the Academy relative to the presentation of papers and arrangement of the hours of meeting beg respectfully to recommend the following changes, viz:

A. In Rule IV, to omit from the first paragraph the words "to receive the titles of papers, reports, etc., and to arrange the order of reading," and in the second paragraph to omit the words "to fix the length of time," etc., to the end, substituting the words "ascertain the length of time required for reading the several memoirs presented, and, when it appears advisable, to recommend a limit of time to be occupied in their discussion.

B. In Rule X, to change the last clause so that it shall read: "The order of their presentation shall be so arranged by the secretary that so far as may be convenient those upon kindred topics shall follow one another."

C. For Rule VII substitute: "Unless otherwise ordered by the Academy the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business."

B. A. GOULD.
J. S. BILLINGS.
A. HALL.

SCIENTIFIC SESSION.

[Held at Philadelphia October 31 to November 1, 1895.]

A scientific session for the reading of papers only having been called by the council, the Academy met in rooms belonging to the department of hygiene in the University of Pennsylvania. The president, Mr. Wolcott Gibbs, presided.

The following named members were present during the session: Agassiz, Barus, Billings, Bowditch, Brewer, Brooks, Brush, Chandler (C. F.), Cope, Emmons, Gibbs (W.), Gill, Gould, Hague, Hall (A.), Hastings, Marsh, Michelson, Mitchell (S. W.), Morse, Powell, Pumpelly, Putnam, Sellers, Verrill, Walker, Welsh, Wood, Young.

The following papers were read:

The Olindiadæ. W. K. Brooks.

New Campanularian Medusæ. W. K. Brooks.

The Filar Anemometer. Carl Barus.

The Countertwisted Curl Aneroid. Carl Barus.

On the Paleozoic Reptilian Order of the Cotylosauria. E. D. Cope.

On a New Variable of Peculiar Character. S. C. Chandler.

On a Bone Cave at Port Kennedy, Pa. E. D. Cope.

On Borings through the Coral Reef in Florida. A. Agassiz.

On the Alkaline Uranates. W. Gibbs.

On the Broadening of Spectral Lines by Temperature and Pressure. A. A. Michelson.

On the Asteroids. A. Hall.

On the Persistency of Fresh Water Types. T. Gill.

The Academy then adjourned to meet in Washington on the third *Tuesday in April, 1896.*

APPENDICES.

APPENDIX A.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888, and April 18, 1895.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its sessions next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those *for the* transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special sessions may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election of officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

SEC. 10. Whenever a member has not paid his dues for four successive years the treasurer shall report the fact to the council, which may report the case to the Academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the Academy and his name shall be dropped from the roll.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author, or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by

the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be, at all times, at the disposition of the Government, upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States; or, with the approval of the council, in State bonds, or first-mortgage bonds on real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receive two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

APPENDIX B.

RULES.

I. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of viva voce votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected, by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented, which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property, owned or held in trust by the Academy, shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year and referred with the accounts to the auditing committee.

IV. A committee of arrangements, consisting of five members, shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members; to arrange the business of each day; and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to ascertain the length of time required for reading the several memoirs presented, and when it appears advisable to recommend a limit of time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.

8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session. But no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date, in the records of the Academy, from the date of their presentation to the Academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred at the meeting at which they are read to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. An annual of the Academy shall be prepared and published by the secretaries.

XIII. The printing of the Academy shall be under the charge of the committee of publication, to consist of the home secretary and four other members to be named by the president, with the advice and consent of the council.

XIV. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XVI. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVII. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVIII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XIX. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XX. At least sixty days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XXI. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXII. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXIII. Any rule of the Academy may be amended, suspended, or repealed, on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, ex officio, a member of all Government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1895.

	Expiration of term.
GIBBS, WOLCOTT, *President*	April, 1901
WALKER, F. A., *Vice-President*	April, 1897
AGASSIZ, A., *Foreign Secretary*	April, 1901
HALL, A., *Home Secretary*	April, 1901
BILLINGS, JOHN S., *Treasurer*	April, 1899

ADDITIONAL MEMBERS OF COUNCIL, 1895–96.

BRUSH, G. J
GOODALE, G. L.
GOULD, B. A.
MARSH, O. C.
NEWCOMB, S.
REMSEN, IRA.

COMMITTEES OF THE ACADEMY.

On Weights, Measures, and Coinage.

GOULD, B. A.
MENDENHALL, T. C.
MICHELSON, A. A.
NEWCOMB, S.
NEWTON, H. A.
PEIRCE, C. S.

YOUNG, C. A.

On the Election of Foreign Associates.

GOULD, B. A.
HALL, A.
AGASSIZ, A.
MITCHELL, S. W.

NEWCOMB, S.

On Publication.

THE HOME SECRETARY.
BILLINGS, J. S.
MENDENHALL, T. C.
NEWCOMB, S.

POWELL, J. W.

On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.
BILLINGS, J. S.
BRUSH, G. J.
POWELL, J. W.

TRUST FUNDS.

Board of Direction of the Bache Fund.

GIBBS, WOLCOTT. GOULD, B. A.
GOODALE, G. L.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.* GOULD, B. A.
HALL, A.

The Henry Draper Fund.

BARKER, G. F., *Chairman.* TROWBRIDGE, J.
NEWCOMB, S. WRIGHT, A. W.
YOUNG, C. A.

The J. Lawrence Smith Fund.

BRUSH, G. J., *Chairman.* JOHNSON, S. W.
HALL, A. PUMPELLY, R.
REMSEN, IRA.

The Barnard Medal.

CHANDLER, C. F., *Chairman.* COMSTOCK, C. B.
BOSS, LEWIS. DANA, E. S.
GOODE, G. B.

The Wolcott Gibbs Fund.

JACKSON, C. L. REMSEN, IRA.
DROWN, T. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, MAY 10, 1895.

		Date of election.
ABBE, CLEVELAND	*Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A.	*Army Building, New York City.*	1872
AGASSIZ, ALEXANDER	*Cambridge, Mass.*	1866
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F.	*3909 Locust St., Philadelphia, Pa.*	1876
BARUS, CARL	*Providence, R. I.*	1892
BELL, A. GRAHAM	*Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A.	*2115 Chestnut St., Philadelphia, Pa.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CASEY, THOMAS L., U. S. A.	*Washington, D. C.*	1890
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C.	*16 Craigie St., Cambridge Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A.	*Army Building, New York City.*	1884
COPE, EDWARD D	*2100 Pine St., Philadelphia, Pa.*	1872
COUES, ELLIOTT	*Washington, D. C.*	1877
CRAFTS, JAMES M	*59 Marlborough St., Boston, Mass.*	1872
DANA, EDWARD S	*New Haven, Conn.*	1884

		Date of election.
DAVIDSON, GEORGE	*San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Washington, D. C.*	1884
ELKIN, WILLIAM L	*New Haven, Conn.*	1895
EMMONS, SAMUEL F	*Washington, D. C.*	1892
FARLOW, W. G	*Cambridge, Mass.*	1879
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
GOODE, G. BROWN	*Washington, D. C.*	1888
GOULD, BENJAMIN A	*Cambridge, Mass.*	——
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH	*Washington, D. C.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*West Nyack, N. Y.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*San Jose, Cal.*	1885
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*New Haven, Conn.*	1866
KING, CLARENCE	*Century Club, New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LEA, M. CAREY	*430 Walnut St., Philadelphia, Pa.*	1892
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LESLEY, J. PETER	*1008 Clinton St., Philadelphia, Pa.*	——
MARSH, O. C	*New Haven, Conn.*	1874
MAYER, ALFRED M	*Hoboken, N. J.*	1872
MAYO-SMITH, RICHMOND	*Columbia College, New York City.*	1890
MENDENHALL, THOMAS C	*Worcester, Mass.*	1887
MICHAEL, ARTHUR	*Somerville, Mass.*	1889
MICHELSON, ALBERT A	*Chicago, Ill.*	1888
MITCHELL, HENRY	*18 Hawthorne St., Boston, Mass.*	1885
MITCHELL, S. WEIR	*1524 Walnut St., Philadelphia, Pa.*	1865
MORSE, EDWARD S	*Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWCOMB, SIMON, U. S. N	*Washington, D. C.*	1869
NEWTON, H. A	*New Haven, Conn.*	——
PACKARD, A. S	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*Milford, Pa.*	1877
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs Ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	*147 S. Fourth St., Philadelphia, Pa.*	——
ROGERS, WILLIAM A	*Waterville, Me.*	1885
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
SARGENT, CHARLES S	*Jamaica Plain, Mass.*	1895
SCHOTT, CHARLES A	*Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877

		Date of election.
SELLERS, WILLIAM	*1600 Hamilton St., Philadelphia, Pa.*	1873
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
TRUMBULL, J. H	*Hartford, Conn.*	1872
VERRILL, A. E	*New Haven, Conn.*	1872
WALKER, FRANCIS A	*Boston, Mass.*	1878
WELCH, WILLIAM H	*Baltimore, Md.*	1895
WHITE, CHARLES A	*Washington, D. C.*	1889
WHITMAN, CHARLES O	*Chicago, Ill.*	1895
WOOD, HORATIO C	*1925 Chestnut St., Philadelphia, Pa.*	1879
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

HONORARY MEMBER.

LYMAN, THEODORE	*Brookline, Mass.*

DECEASED MEMBERS.

	Date of death.
*AGASSIZ, LOUIS	Dec. 14, 1873
*ALEXANDER, J. H	Mar. 2, 1867
*ALEXANDER, STEPHEN	June 25, 1883
*BACHE, ALEXANDER DALLAS	Feb. 14, 1867
*BAIRD, SPENCER F	Aug. 19, 1887
BARNARD, F. A. P	Apr. 27, 1889
BARNARD, J. G	May 14, 1882
BARTLETT, W. H. C	Feb. 11, 1893
BROWN-SEQUARD, CHARLES E	Apr. 2, 1894
*CASWELL, ALEXIS	Jan. 8, 1887
*CHAUVENET, WILLIAM	Dec. 13, 1870
*CLARK, HENRY JAMES	July 1, 1873
*COFFIN, JAMES H	Jan. 6, 1873
COFFIN, J. H. C	Jan. 8, 1890
COOK, GEORGE H	Sept. 22, 1889
*DALTON, J. C	Feb. 2, 1889
DANA, JAMES D	Apr. 14, 1895
DAVIS, CHARLES H	Feb. 18, 1877
*DRAPER, HENRY	Nov. 20, 1882
*DRAPER, JOHN W	Jan. 4, 1882
*EADS, JAMES B	Mar. 8, 1887
ENGELMANN, GEORGE	Feb. 4, 1884
*FERREL, WILLIAM	Sept. 18, 1891
*FRAZER, JOHN FRIES	Oct. 12, 1872
*GABB, WILLIAM M	May 30, 1878
GENTH, F. A	Feb. 2, 1893
*GILLISS, JAMES MELVILLE	Feb. 9, 1865
*GOULD, AUGUSTUS A	Sept. 15, 1866
*GRAY, ASA	Jan. 30, 1888
*GUYOT, ARNOLD	Feb. 8, 1884
*HADLEY, JAMES	Aug. 1, 1864
*HALDEMAN, S. S	Sept. 20, 1880
HAYDEN, F. V	Dec. 22, 1887
*HENRY, JOSEPH	May 13, 1878
*HILGARD, JULIUS E	May 8, 1891
*HITCHCOCK, EDWARD	Feb. 27, 1864

*Biographical notices have been presented of those designated by an asterisk.

	Date of death.
*HOLBROOK, J. E	Sept. 8, 1871
*HUBBARD, J. S	Aug. 16, 1863
*HUMPHREYS, A. A	Nov. 28, 1883
HUNT, T. STERRY	Feb. 12, 1892
*KIRKLAND, JARED P	Dec. 10, 1877
*LANE, J. HOMER	May 3, 1880
*LE CONTE, JOHN	Apr. 29, 1891
*LE CONTE, JOHN L	Nov. 15, 1883
LEIDY, JOSEPH	Apr. 30, 1891
*LESQUEREUX, LEO	Oct. 25, 1889
LONGSTRETH, MIERS F	Dec. 27, 1891
*LOOMIS, ELIAS	Aug. 16, 1889
LOVERING, JOSEPH	Jan. 18, 1892
*MAHAN, D. H	Sept. 16, 1871
*MARSH, G. P	July 23, 1882
*MEEK, F. B	Dec. 21, 1877
*MEIGS, M. C	Jan. 2, 1892
*MORGAN, LEWIS H	Dec. 14, 1881
NEWBERRY, J. S	Dec. 7, 1892
NEWTON, JOHN	May 1, 1895
*NORTON, WILLIAM A	Sept. 21, 1883
OLIVER, JAMES E	Mar. 27, 1895
PETERS, C. H. F	July 18, 1890
*POURTALES, L. F	July 19, 1880
RODGERS, JOHN	May 5, 1882
ROGERS, ROBERT E	Sept. 7, 1884
*ROGERS, WILLIAM B	May 30, 1882
*RUTHERFURD, LEWIS M	May 30, 1892
*SAXTON, JOSEPH	Oct. 26, 1873
*SILLIMAN, BENJ., Sr	Nov. 24, 1864
SILLIMAN, BENJ., Jr	Jan. 14, 1885
*SMITH, J. LAWRENCE	Oct. 12, 1883
*STIMPSON, WILLIAM	May 26, 1873
*STRONG, THEODORE	Feb. 1, 1869
*SULLIVANT, W. S	Apr. 30, 1873
*TORREY, JOHN	Mar. 10, 1873
*TOTTEN, J. G	Apr. 22, 1864
*TROWBRIDGE, WILLIAM P	Aug. 12, 1892
*TUCKERMAN, EDWARD	Mar. 15, 1886
*WARREN, G. K	Aug. 8, 1882
*WATSON, JAMES C	Nov. 23, 1880
*WATSON, SERENO	Mar. 9, 1892
*WINLOCK, JOSEPH	June 11, 1875
*WOODWARD, J. J., U. S. A	Aug. 17, 1884
*WORTHEN, A. H	May 6, 1888
*WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

BUNSEN, ROBERT W	*Heidelberg.*
STRUVE, OTTO VON	*Pulkowa.*
STOKES, SIR GEORGE G	*Cambridge.*
SYLVESTER, J. J	*Oxford.*

* Biographical notices have been presented of those designated by an asterisk.

HOOKER, SIR J. D	*Kew.*
LORD KELVIN	*Glasgow.*
AUWERS, ARTHUR	*Berlin.*
BERTRAND, J. L. F	*Paris.*
VIRCHOW, RUDOLPH VON	*Berlin.*
BERTHELOT, M. P. E	*Paris.*
KÖLLIKER, ALBERT VON	*Würzburg.*
RICHTHOFEN, F. VON	*Berlin.*
GEGENBAUR, CARL	*Heidelberg.*
DU BOIS REYMOND, EMIL	*Berlin.*
WEIERSTRASS, KARL	*Berlin.*
GYLDÉN, HUGO	*Stockholm.*
KEKULÉ, AUGUST	*Bonn.*
TISSERAND, F. F	*Paris.*
RAMMELSBERG, K. F	*Berlin.*
LEUCKART, RUDOLPH	*Leipzig.*
SACHS, JULIUS VON	*Würzburg.*
LIE, SOPHUS	*Leipzig.*

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.
CARL ERNST VON BAER.
HENRY MILNE-EDWARDS.
MICHAEL FARADAY.
L. ELIE DE BEAUMONT.
SIR DAVID BREWSTER.
G. A. A. PLANA.
F. W. A. ARGELANDER.
FRIEDRICH WÖHLER.
J. B. DUMAS.
J. B. J. D. BOUSSINGAULT.
M. E. CHEVREUL.
MICHEL CHASLES.
SIR GEORGE B. AIRY.
J. C. ADAMS.
SIR RICHARD OWEN.
C. H. C. BURMEISTER.
ARTHUR CAYLEY.
T. H. HUXLEY.
SIR RODERICK I. MURCHISON.
VICTOR REGNAULT.
H. W. DOVE.
C. A. F. PETERS.
JUSTUS VON LIEBIG.
ALEXANDER BRAUN.
JOACHIM BARRANDE.
ADOLPHE WÜRTZ.
THEODORE VON OPPOLZER.
G. R. KIRCHOFF.
RUDOLPH CLAUSIUS.
JAMES P. JOULE.
CARLOS IBAÑEZ.
JEAN SERVAIS STAS.
ALPHONSE DE CANDOLLE.
A. W. HOFMANN.
BARON H. VON HELMHOLTZ.
K. F. W. LUDWIG.
LOUIS PASTEUR.

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1896.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

LETTER

FROM THE

PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES,

TRANSMITTING

A report of the operations of the National Academy of Sciences during the year 1896.

JANUARY 7, 1897. — Referred to the Committee on Printing and ordered to be printed.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 1, 1897.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences for the past year.

Very respectfully,

WOLCOTT GIBBS,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

ACT OF INCORPORATION.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own

organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 24, 1884.*

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

SESSIONS OF THE NATIONAL ACADEMY.

During the year 1896 the Academy held three sessions. The first was the regular annual session, held at Washington, April 21 to 24. The second was a scientific session, held at New York, November 17 to 18. The third, a special session, held at New York, November 18, for the transaction of business.

ANNUAL MEETING.

[Held at Washington, April 21 to 24, 1896.]

The session was held in the National Museum, the president, Mr. Wolcott Gibbs, presiding.

The following members were present during the session: Abbe, Billings, Boss, Brewer, Cope, Emmons, W. Gibbs, Gill, Goode, Gould, Hague, A. Hall, G. W. Hill, Marsh, Mayer, Mendenhall, Powell, Remsen, W. A. Rogers, Rood, Sargent, Schott, Scudder, Sellers, Verrill, Walker, White, Barns, Bowditch, Brooks, Hastings, Hyatt, Michelson, Morse, Putnam, Rowland, Welch, Wright, Gilbert, Mayo-Smith.

The home secretary submitted the following report for the past year:

REPORT OF THE HOME SECRETARY.

The printing of the third volume of Biographical Memoirs was finished during the last year and the volume has been distributed to members of the Academy.

The third volume of the Proceedings was printed and distributed. This volume brings the account of the work of the Academy up to the year 1890.

The seventh volume of the memoirs of the Academy has just been printed, and the distribution of this volume is going on.

REPORT OF THE TREASURER.

WASHINGTON, D. C., *April 21, 1896.*

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 21, 1896:

Income.	General fund.	Bache fund.	Watson fund.	Draper fund.	Smith fund.	Gibbs fund.
Balance April 16, 1895:						
Cash	$409.99	$4,320.17	$447.75	$402.72	$456.08	.....
Invested	*a* 500.00	.....	*a* 1,500.00 *b* 826.83 *c* 500.00 *d* 1,000.00 *e* 400.00 *f* 200.00	*e* 600.00 *g* 400.00 *f* 300.00	*h* 596.57	.....
United States Treasury warrant (reimbursement)	69.00	.....	.....	.....	.....	.....
Interest received during 1895–96	18.26	2,809.51	1,273.34	428.20	558.15	$133.66
Received from members' tax	475.00	.....	.....	.....	.....	.....
Total to account for	1,472.25	7,129.68	6,147.92	2,130.92	1,610.80	133.66
Disbursed in 1895–96	666.17	1,905.96	454.57	7.15	9.50	133.66
Invested income transferred to capital fund	.....	.....	*a* 1,000.00 *b* 233.12 *c* 500.00 *d* 1,000.00 *e* 400.00 *f* 200.00	*e* 600.00 *g* 400.00 *f* 300.00	.....	.....
Balance April 21, 1896:						
Cash	306.08	5,223.72	1,266.52	823.77	1,004.73	.....
Loans	*a* 500.00	.....	*a* 500.00 *b* 593.71	.....	*h* 596.57	.....
Total accounted for	1,472.25	7,129.68	6,147.92	2,130.92	1,610.80	133.62
Available balance, less obligations	306.08	3,671.72	1,266.52	823.77	1,004.73	.....

a District of Columbia bonds, 3.65 per cent.
b Ernshaw loan, 5 per cent.
c Cosmos Club bonds, 5 per cent.
d Walter loan, 5½ per cent.
e Morris loan, 5 per cent.
f Smith loan, 5 per cent.
g Simpson loan, 5 per cent.
h Webb loan, 5 per cent.

The Dubant loan was renewed to include September 28, 1898, at the same rate.

Cosmos Club bond No. 145, first series, held by the Watson fund, was called in and canceled January 13, 1896. The sum received remains uninvested.

The Watson and the Draper funds have been increased to $22,000 and $7,903.75, respectively, by the transfer of invested income of each.

The expenses of the electrical committee—$69—previously reported, have been paid by the United States Treasurer, and that sum was reimbursed to the general fund, from which the expenses had been paid.

The treasurer's bond was renewed to June 30, 1896, the expense of same being distributed to the several funds, as in previous years.

Very respectfully,

J. S. BILLINGS, *Treasurer.*

REPORT OF THE COMMITTEE APPOINTED TO EXAMINE THE REPORT OF THE TREASURER.

WASHINGTON, D. C., *April 22, 1896.*

The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances correspond to the vouchers, books, and accounts of the treasurer and are found correct.

CLEVELAND ABBE.
THEO. N. GILL.

PAPERS READ AT THE ANNUAL MEETING.

*The Geological Efficacy of Alkali Carbonate Solutions. E. W. Hilgard.

*On the Color Relations of Atoms, Ions, and Molecules. M. Carey Lea.

*On the Characters of the Otocœlidæ. E. D. Cope.

*Exhibition of a Linkage whose Motion shows the Laws of Refraction of Light. A. M. Mayer.

*Location in Paris of the Dwelling of Malus, in which he made the Discovery of the Polarization of Light by Reflection. A. M. Mayer.

*(1) On Experiments showing that the X-Rays can not be Polarized by passing through Herapathite; (2) The Density of Herapathite; (3) Formulæ of Transmission of the X-Rays through Glass, Tourmaline, and Herapathite. A. M. Mayer.

‡On the X-Rays from a Statical Current produced by a Rapidly Revolving Leather Belt. W. A. Rogers and Frederick Brown.

‡Biographical Memoir of James Edward Oliver. G. W. Hill.

‡Biographical Memoir of Charles Henry Davis. C. H. Davis.

‡Biographical Memoir of George Engelmann. C. A. White.

Legislation Relating to Standards. T. C. Mendenhall.

†On the Determination of the Coefficient of Expansion of Jessop's Steel, between the Limits of 0° and 64° C., by the Interferential Method. E. W. Morley and W. A. Rogers.

†On the Separate Measurement, by the Interferential Method, of the Heating Effect of Pure Radiations and of an Envelope of Heated Air. W. A. Rogers.

On the Logic of Quantity. C. S. Peirce.

Judgment in Sensation and Perception. J. W. Powell.

The Variability in Fermenting Power of the Colon Bacillus under Different Conditions. By A. W. Peckham. (Presented by J. S. Billings.)

Experiments on the Reflection of Röntgen Rays. O. N. Rood.

Notes on Röntgen Rays. H. A. Rowland.

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*Read April 21. †Read April 23. ‡Read April 22.

Some Studies in Chemical Equilibrium. Ira Remsen.

The Decomposition of Diazo-compounds by Alcohol. Ira Remsen.

On Double Halides containing Organic Bases. Ira Remsen.

*Results of Researches of Forty Binary Stars. T. J. J. See.

On a Remarkable New Family of Deep-sea Cephalopoda and its bearing on Molluscan Morphology. A. E. Verrill.

The Question of the Molluscan Archetype, an Archi-mollusk. A. E. Verrill.

On some Points in the Morphology and Phylogeny of the Gastropoda. A. E. Verrill.

*Source of X-Rays. A. A. Michelson and S. W. Stratton.

The Relative Permeability of Magnesium and Aluminum to the Röntgen Rays. A. W. Wright.

The State of Carbon-dioxide at the Critical Temperature. C. Barus.

The Motion of a Submerged Thread of Mercury. C. Barus.

On a Method of Obtaining Variable Capillary Apertures of Specified Diameter. C. Barus.

On a New Type of Telescope Free from Secondary Color. C. S. Hastings.

The Olindiadæ and other Medusæ. W. K. Brooks.

Budding in Perophora. W. K. Brooks and George Lefevre.

Anatomy of Yoldia. W. K. Brooks and Gilman Drew.

On the Pithecanthropus erectus from the Tertiary of Java. O. C. Marsh.

ELECTION OF NEW MEMBERS.

Two new members of the Academy were elected at this session—Robert S. Woodward, of New York, and Charles D. Walcott, of Washington, D. C.

During the year the Academy lost by death Mr. H. A. Newton, Mr. G. Brown Goode, and Mr. Benjamin A. Gould, members, and Mr. Tisserand, Mr. Gylden, Mr. Kekule, and Mr. Dubois-Reymond, foreign associates.

AMENDMENT TO THE RULES.

Rule XII, relating to the publication by the Academy of an annual, was stricken out.

REPORT FROM TRUST FUNDS.

Mr. Wolcott Gibbs reported that during the year 1896 the following appropriations were made from the Bache fund: An appropriation of $1,000 to Mr. Henry A. Rowland, to carry on an investigation of the spectra of the elements in continuation of his work on the spectrum of the sun; an appropriation of $100 to Mr. Alpheus S. Packard, to enable him to carry on an investigation of the life histories and transformations of the bombycine moths, in continuation of his work in Memoirs of the *National Academy of* Sciences, Volume VII; an appropriation of $400 to

*Read April 22.

Mr. Ira Remsen, for an investigation of the atomic weights of zinc and cadmium, to be conducted by Mr. H. N. Morse; an appropriation of $1,000 to Mr. J. S. Billings and Mr. S. Weir Mitchell, to enable them to carry on an investigation of the variability of bacteria, being a continuation of researches already in progress.

SCIENTIFIC SESSION.

[Held in New York November 17 and 18, 1896.]

A scientific session, for the reading of papers only, having been called by the council, the Academy met at Columbia University, New York. The vice-president, Mr. F. A. Walker, presided.

The following-named members were present during the session: Abbot, Allen, Barker, Barus, Billings, Bowditch, Brewer, Chandler, C. F.; Cope, Comstock, Dana, Emmons, Gould, Hall, A.; Hastings, Hill, G. W.; Le Conte, Marsh, Mayer, Mayo-Smith, Mendenhall, Michael, Michelson, Mitchell, S. W.; Newcomb, Packard, Peirce, Pumpelly, Remsen, Rood, Rowland, Sargent, Verrill, Walker, Welch, Woodward, Wright.

The following papers were read:

On Certain Positive-Negative Laws in their Relation to Organic Chemistry. A. Michael.

The Jurassic Formation on the Atlantic Coast. O. C. Marsh.

The Hydrolysis of Acid Amides. Ira Remsen.

The Isomeric Chlorides of Paranitroorthosulphobenzoic Acid. Ira Remsen.

The Equations of the Forces Acting in the Flotation of Disks and Rings of Metal, with Experiments showing the Floating of Loaded Disks and Rings of Metal on Water and on other Liquids. Alfred M. Mayer.

On the Geographical Distribution of Bactrachia and Reptiles in the Medicolumbian Region. E. D. Cope.

On the Physical Causes of the Periodic Variation of Latitude. S. Newcomb.

On the Solar Motion as a Gauge of Stellar Disturbances. S. Newcomb.

Memoir of F. B. Meek. C. A. White.

The Evolution and Phylogeny of Gastropod Mollusca. A. E. Verrill.

On Flicker Photometers. O. N. Rood.

A New Type of Telescope free from Secondary Color. C. H. Hastings (read by title at Washington, April, 1896).

A Graphical Method of Logic. C. S. Peirce.

Mathematical Infinity. C. S. Peirce.

BUSINESS MEETING.

[Held in New York, November 18, 1896.]

A business meeting of the Academy having been called by the council to consider the report of the president to Congress, and such other business as might be presented, was held November 18. The vice-president, Mr. F. A. Walker, presided.

After the call of the roll the vice-president presented an outline of the president's report to Congress for the year 1896. Upon the recommendation of the council the Academy authorized the president to present his report to Congress and to include in this report the proceedings of the present meeting and also any Government business that may come before the Academy.

The Academy was called to order by the vice-president at 11 a. m. The following-named members were present: Abbott, Barus, Billings, Bowditch, Brewer, Chandler (C. F.), Emmons, Gould, Hall (A.), Marsh, Newcomb, Peirce, Pumpelly, Remsen, Walker.

The vice-president stated that the Academy had lost by death two members since the last meeting: Mr. G. Brown Goode and Mr. H. A. Newton, the latter one of the charter members. Mr. S. P. Langley was appointed to prepare a biographical memoir of Mr. Goode, and Mr. J. Willard Gibbs was appointed to prepare the memoir of Mr. Newton.

The Academy then adjourned to meet in Washington on the third Tuesday in April, 1897.

BUSINESS FROM CONGRESS AND FROM DEPARTMENTS OF THE GOVERNMENT OF THE UNITED STATES.

During the year ending January 1, 1897, the Academy has received three communications on public business. The first was from Hon. Hoke Smith, Secretary of the Interior, requesting from the Academy an investigation and report on the inauguration of a rational forest policy for the forested lands of the United States.

The second, from the Bureau of Animal Industry of the Department of Agriculture, asking the Academy to appoint one of its members as a representative upon an advisory board to consider propositions to be submitted to the International Zoological Congress to be held in England in 1898, by Mr. Ch. Wardell Stiles, United States Government delegate to the Third International Zoological Congress.

The President appointed Mr. Gill as the representative of the Academy.

The third was from the Hon. Jacob H. Gallinger, chairman of a subcommittee of the Senate, submitting a letter addressed to him by the Chief of the Bureau of Animal Industry, the Surgeon-General of the Army, the Surgeon-General of the Navy, and the Surgeon-General of the Marine-Hospital Service, asking that the National Academy of Sciences be called upon to express an opinion as to the scientific value of experiments upon the lower animals and as to the probable effect of restrictive legislation upon the advancement of biological science. The letter as transmitted by Senator Gallinger to the Academy was accompanied by a brief expression of his desire that the Academy should report upon the subject.

To Prof. Wolcott Gibbs, President of the National Academy of Sciences.

DEPARTMENT OF THE INTERIOR,
Washington, February 15, 1896.

SIR: I have the honor, as the head of the Department charged with the administration of the public domain, to request an investigation and report of your honorable body, as is provided in the act incorporating the National Academy, and by article 5, section 5, of its constitution, upon the inauguration of a rational forest policy for the forested lands of the United States.

Being convinced of the necessity for a radical change in the existing policy with reference to the disposal and preservation of the forests upon the public domain, I particularly desire an official expression from your body upon the following points:

1. Is it desirable and practicable to preserve from fire and to maintain permanently as forested lands those portions of the public domain now bearing wood growth for the supply of timber?

2. How far does the influence of forest upon climatic, soil, and water conditions make desirable a policy of forest conservation in regions where the public domain is principally situated?

3. What specific legislation should be enacted to remedy the evils now confessedly existing?

My predecessors in office for the last twenty years have vainly called attention to the inadequacy and confusion of existing laws relating to the public timber lands, and consequent absence of an intelligent policy in their administration, resulting in such conditions as may, if not speedily stopped, prevent a proper development of a large portion of our country; and because the evil grows more and more as the years go by, I am impelled to emphasize the importance of the question by calling upon you for the opinion and advice of that body of scientists which is officially empowered to act in such cases as this.

I also beg to refer you to the proposed legislation which has been introduced into Congress for several years past at the instance of the American Forestry Association, supported by memorials of private citizens and scientific bodies, and more especially the memorials presented by the American Association for the Advancement of Science in 1873, which led to desirable legislation, and again in 1890, 1892, and 1894.

As I believe that a speedy change in the existing policy is urgent, I request that you will give an early consideration to this matter, and favor me with such statements and recommendations as may be laid before Congress for action during this session.

I have the honor to be, your obedient servant,

HOKE SMITH, *Secretary.*

Copy of letter to the Secretary of the Interior.

FEBRUARY 16, 1896.

SIR: I have the honor to acknowledge the receipt of your communication of February 15, 1896, requesting from the National Academy of Sciences an official expression of opinion upon the inauguration of a rational forest policy for the forested lands of the United States.

The subject will receive my immediate attention and you will be promptly informed of the action of the Academy.

I am, sir, very respectfully, your obedient servant,

WOLCOTT GIBBS,
President of the National Academy of Sciences.

To the Hon. Hoke Smith, Secretary of the Interior.

NEWPORT, R. I., *March 2, 1896.*

SIR: I have submitted to the consideration of the vice-president and other members of the National Academy of Sciences your letter of February 17 in relation to the forest policy of the United States, and now respectfully ask your attention to the following statement in reply:

It is needless to remind you that the matter you refer to the Academy is important and difficult. No subject upon which the Academy has been asked before by the Government for advice compares with it in scope, and it is the opinion of thoughtful men that no other economic problem confronting the Government of the United States equals in importance that offered by the present condition and future fate of the forests of western North America.

The forests in the public domain extend through 18° of longitude and 20° of latitude; they vary in density, composition, and sylvicultural condition from the most prolific in the world outside the tropics to the most meager; in some parts of the country they are valuable as sources of timber supply which can be made permanent; in others, while producing no timber of importance, they are not less valuable for their influence upon the supply of water available for the inhabitants of regions dependent on irrigation for their means of subsistence. The character of the topography and the climate of most of the region now embraced in the public domain increase the difficulty of the problem. Scanty and unequally distributed rainfall checks the growth of forests, while high mountain ranges make them essential to regulate the flow of mountain streams.

You have done the Academy the honor of asking it to recommend a plan for the general treatment of the forest-covered portions of the public domain. That its report may be valuable as a basis for future legislation it must consider—

1. The question of the ultimate ownership of the forests now belonging to the Government—that is, what portions of the forest on the public domain shall be allowed to pass, either in part or entirely, from Government control into private hands?

2. How shall the Government forests be administered so that the inhabitants of adjacent regions may draw their necessary forest supplies from them without affecting their permanency?

3. What provision is possible and necessary to secure for the Government a continuous, intelligent, and honest management of the forests of the public domain, including those in the reservations already made or which may be made in the future?

In the successful management of forests permanency in control—that is, the possibility of carrying out the details of plans made to extend perhaps through centuries—is essential; and not the least important part of the problem which you have referred to the Academy is the consideration of the organization needed to administer the Government forests, which already cover in established reservations several millions of acres.

The Academy will bring to the consideration of these problems the ability, the patriotism, and the disinterestedness of its members best fitted by special training and knowledge to deal with them. The scope of the investigation, however, is so broad, involving as it does the future of a considerable part of the United States and millions of its inhabitants, that you will, I am sure, realize that it is impossible to present a final report before the adjournment of the present Congress. The committee of the Academy will require the counsels of a lawyer familiar with the decisions of the General Land Office, and I respectfully request that you will designate one of the law officers of your Department to aid it, and that a room in the Department and clerical assistance, when needed, may be provided for the Commission or its secretary.

Questions submitted by Congress or by the Departments to the National Academy of Sciences are referred to special committees appointed by the president of the Academy with the advice of members familiar with the special subjects requiring examination and report. Experts not members of the Academy may, if desirable, be appointed on such committees. In the case of the very important questions upon which you have asked the advice of the Academy, I have appointed as an appropriate commission the following-named persons, of whom one only is not a member of the Academy, but all of whom are eminently qualified by previous study and active field work to prepare a report upon which legislation may be based.

Chairman, Prof. Charles S. Sargent, director of the Arnold Arboretum, author of the Sylva of the United States and of numerous papers upon arboriculture; conductor of Garden and Forest.

Mr. Alexander Agassiz.

Gen. Henry L. Abbott, an eminent engineer and hydrographer familiar with the Western country.

Prof. William H. Brewer, of Yale University, a prominent botanist and agriculturist, who has served on the geological surveys of California, also familiar with the country west of the Mississippi.

Mr. Arnold Hague, of the United States Geological Survey, well known as a prominent geologist.

Mr. Gifford Pinchot, who has a very high reputation as an arboriculturist.

In addition to these, the president of the Academy is ex officio a member of all commissions appointed at the request of Congress or by any of the Departments.

The members of the Academy serve the Government without compensation; but it is evidently proper that provision should be made for refunding their traveling and other absolutely necessary expenses, and for such field and other work as may be necessary to enable the Commission to prepare its report intelligently, and I respectfully suggest that a sum of money, not exceeding $25,000, be placed at the disposal of the Commission for the purposes of this investigation.

Very respectfully, your obedient servant,

WOLCOTT GIBBS,
President of the National Academy of Sciences.

To the Hon. Jacob D. Francis, Secretary of the Interior.

NEWPORT, R. I., *October 26, 1896.*

SIR: The Commission appointed by me, at the request of the Hon. Hoke Smith, Secretary of the Interior of the United States, to examine the forests on the national domain, and to recommend a system of general forest management for the nation, has lately returned from the West, where it has passed the summer in studying the composition and condition of all the great forest region of the Pacific States and Territories, and in gathering testimony bearing upon the question of forest protection and the relation of forests to population, present and future. The Commission is now engaged in preparing its report, which I have reason to hope I shall be able to transmit to the Secretary during the coming year.

Very respectfully, yours,

WOLCOTT GIBBS,
President of the National Academy of Sciences.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., April 21, 1896.

SIR: At the meeting of the third International Zoological Congress, held at Leyden in September, 1895, an international commission of five members was appointed to study all of the codes of zoological nomenclature proposed in various countries, to compare these codes with the present international code, and to report at the next international congress in England, 1898, any recommendations and amendments to the *international code* which the commission should think advisable; also *to make an official translation* of the code from the French into English *and German.*

The members of this commission are: Dr. Slater (England), Dr. Raphael Blanchard (France), Prof. Victor Carus (Germany), Professor Jentink (Holland), and Dr. Stiles (United States).

Upon returning from the congress to this country I immediately suggested to certain American zoologists the advisability of the appointment of an American advisory board, to which I might submit for approval or disapproval all the propositions I intend to support in the meetings of the international commission, and as this plan met with favor, I have addressed certain scientific bodies, requesting of each the appointment of a representative upon the advisory board. In response to these requests the following gentlemen have thus far been appointed: By the Smithsonian Institution, Dr. Dall; by the Society of American Naturalists, Professor Cope; by the American Ornithologists' Union, Dr. Allen.

The matter will also be brought to the attention of the Royal Society of Canada and the American Association for the Advancement of Science at their next meeting. In accordance with their general plan as set forth in this letter and in the inclosed clipping, I respectfully request that the National Academy of Sciences appoint one of its members as a representative upon this advisory board. In making this request I agree that my vote upon any given proposition in the international commission shall be governed by this advisory board, should the occasion arise that my personal opinion upon that proposition differs from the opinion of the advisory board.

Hoping that the Academy will be willing to appoint the representative desired, I remain, very respectfully, yours,

CH. WARDELL STILES,
Zoologist, Bureau of Animal Industry, and
United States Government Delegate to the
Third International Zoological Congress.

Prof. WOLCOTT GIBBS,
President of the National Academy of Sciences.

To the Hon. Jacob H. Gallinger, Senator of the United States, Chairman of Subcommittee, etc.

WASHINGTON, D. C., *April 21, 1896.*

SIR: Referring to Senate bill 1552, we respectfully invite your attention to the fact that the National Academy of Sciences is now in session in this city, and that this body is generally recognized as the highest scientific tribunal in the United States; also that the act incorporating it contains the following clause: "And the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art." (Act approved March 3, 1863.)

We respectfully request that the National Academy of Sciences be called upon to express an opinion as to the scientific value of experiments upon the lower animals and as to the probable effect of restrictive legislation upon the advancement of biological science.

Very respectfully,

D. E. SALMON,
Chief of the Bureau of Animal Industry.
J. R. TRYON,
Surgeon-General U. S. N.
GEO. M. STERNBERG,
Surgeon-General U. S. A.
WALTER WYMAN,
Surgeon-General United States Marine-Hospital Service.

To the Hon. Jacob H. Gallinger.

WASHINGTON, D. C., *April 24, 1896.*

SIR: I have the honor to acknowledge the receipt of a letter addressed to you by D. E. Salmon, the Chief of the Bureau of Animal Industry; J. R. Tryon, Surgeon-General United States Navy; George M. Sternberg, Surgeon-General United States Army, and Walter Wyman, Surgeon-General United States Marine-Hospital Service, asking that the National Academy of Sciences be called upon to express an opinion as to the scientific value of experiments upon the lower animals and as to the probable effect of restrictive legislation upon the advancement of biological science. The letter of these gentlemen is supplemented by an expression of your desire that the National Academy of Sciences should report or make suggestions upon the subject. In accordance with your request, I have the honor to submit to you the following report as the expression of the opinion of the National Academy of Sciences:

Biology is the science of living organisms and tissues, and must therefore advance by means of observations and experiments made upon living beings. One of its most important branches, viz, physiology, or the science which deals with all the phenomena of life, from the activity of bacteria to that of the brain cells of man, forms the foundation upon which the science and practice of medicine are built up, since a knowledge of the bodily functions in their normal state is essential for the understanding and treatment of those derangements of function which constitute disease.

The fact that the pursuit of physiology consists chiefly in the study of physical and chemical phenomena as manifested by living beings makes it necessary that physiology should be studied by experimental

methods. The physiologist, no less than the physicist and the chemist, can expect advancement of his science only as the result of carefully planned laboratory work. If this work is interfered with, medical science will continue to advance, as heretofore, by means of experiment, for no legislation can affect the position of physiology as an experimental science; but there will be this important difference, that the experimenters will be medical practitioners and the victims human beings.

That animals must suffer and die for the benefit of mankind is a law of nature, from which we can not escape if we would, and as long as man claims dominion over the brute creation and asserts his right to kill and mutilate animals in order to obtain food and clothing, and even for purposes of amusement and adornment, it is surely unreasonable to wage a humanitarian warfare against the only kind of pain-giving practice that has for its object the relief of pain.

The death of an animal in a physiological laboratory is usually attended with less suffering than is associated with so-called natural deaths, for the discovery of anæsthetics has extended its beneficent influence over the lower animals as well as over the human race, and in modern laboratories anæsthetics are always employed, except when the operation involves less suffering to the animal than the administration of the anæsthetic (as in the case of inoculations) or in those rare instances in which the anæsthetic would interfere with the object of the experiment. The suffering incident to biological investigation is therefore trifling in amount and far less than that which is associated with most other uses which man makes of the lower animals for purposes of business or pleasure.

As an offset to this trifling amount of animal suffering are to be placed incalculable benefits to the human race. From the time when Aristotle first discovered the insensibility of the brain to the time when the latest experiments in the use of antitoxin have largely robbed diphtheria of its terrors, almost every important advance in the science of medicine has been the direct or the indirect result of knowledge acquired through animal experimentation.

It is, of course, conceivable that persons whose occupations lead them to sacrifice animal life for scientific purposes may at times pay too little regard to the suffering which they inflict, but the Academy understands that even those who advocate restrictive legislation by Congress do not claim that such abuses exist in the District of Columbia, and until evidence of this sort is presented it would seem to be the part of wisdom to leave the regulation of research in the hands of the governing bodies of the institutions in which the work is going on. The men engaged in this work are actuated by motives no less humane than those which guide the persons who desire to restrict their action. Of the value of any given experiment and of the amount of suffering which it involves they are, owing to their special training, much better able to judge.

When the men to whom the Government has intrusted the care of its higher institutions of research shall show themselves incapable of administering them in the interest of science and humanity, then, and not till then, will it be necessary to invoke the authority of the National Legislature.

I have the honor to be, sir, very respectfully, your obedient servant,

WOLCOTT GIBBS,

President of the National Academy of Sciences.

APPENDICES.

APPENDIX A.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888, and April 18, 1895.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its sessions next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes; and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those *for the transaction of* business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special sessions may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately, unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election of officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot, the members present may proceed to elect new members in the following manner: At each ballot, each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be *elected at that session.*

Before and during elections, a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

SEC. 10. Whenever a member has not paid his dues for four successive years the treasurer shall report the fact to the council, which may report the case to the Academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the Academy and his name shall be dropped from the roll.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author, or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy *shall be submitted* to the council for approval, except those requested *by the Government* of the United States, which shall be acted on by

the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be, at all times, at the disposition of the Government, upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States; or, with the approval of the council, in State bonds, or first-mortgage bonds on real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receive two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

APPENDIX B.

RULES.

I. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of viva voce votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected, by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented, which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property, owned or held in trust by the Academy, shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year and referred with the accounts to the auditing committee.

IV. A committee of arrangements, consisting of five members, shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members; to arrange the business of each day; and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to ascertain the length of time required for reading the several memoirs presented, and when it appears advisable to recommend a limit of time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.

8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session. But no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date, in the records of the Academy, from the date of their presentation to the Academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred at the meeting at which they are read to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. The printing of the Academy shall be under the charge of the committee of publication, to consist of the home secretary and four other members to be named by the president, with the advice and consent of the council.

XIII. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XIV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XV. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVI. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVII. The treasurer is authorized to defray, when approved by the *president, all the proper* expenses of committees appointed to make

scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XVIII. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XIX. At least sixty days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XX. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXI. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXII. Any rule of the Academy may be amended, suspended, or repealed, on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, ex officio, a member of all Government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1896.

	Expiration of term.
GIBBS, WOLCOTT, *President*	April, 1901
WALKER, F. A., *Vice-President*	April, 1897
AGASSIZ, A., *Foreign Secretary*	April, 1901
HALL, A., *Home Secretary*	April, 1901
BILLINGS, JOHN S., *Treasurer*	April, 1899

ADDITIONAL MEMBERS OF COUNCIL, 1896-97.

BOWDITCH, H. P.
BRUSH, G. J.
GOODALE, G. L.
MARSH, O. C.
NEWCOMB, S.
REMSEN, IRA.

COMMITTEES OF THE ACADEMY.

On Weights, Measures, and Coinage.

MENDENHALL, T. C.
MICHELSON, A. A.
NEWCOMB, S.
PEIRCE, C. S.
YOUNG, C. A.

On the Election of Foreign Associates.

HALL, A.
AGASSIZ, A.
MITCHELL, S. W.
NEWCOMB, S.

On Publication.

THE HOME SECRETARY.
BILLINGS, J. S.
MENDENHALL, T. C.
NEWCOMB, S.
POWELL, J. W.

On Publications of the Academy.

GILL, T.

On the Relation of the Academy to the Government.

THE PRESIDENT.
VICE-PRESIDENT.
SECRETARIES.
BILLINGS, J. S.
BRUSH, G. J.
POWELL, J. W.

TRUST FUNDS.

Board of Direction of the Bache Fund.

GIBBS, WOLCOTT.
CHANDLER, S. C.
GOODALE, G. L.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.* HALL, A.

The Henry Draper Fund.

BARKER, G. F., *Chairman.* TROWBRIDGE, J.
NEWCOMB, S. WRIGHT, A. W.
YOUNG, C. A.

The J. Lawrence Smith Fund.

BRUSH, G. J., *Chairman.* JOHNSON, S. W.
HALL, A. PUMPELLY, R.
REMSEN, IRA.

The Barnard Medal.

CHANDLER, C. F., *Chairman.* COMSTOCK, C. B.
BOSS, LEWIS. DANA, E. S.

The Wolcott Gibbs Fund.

JACKSON, C. L. REMSEN, IRA.
DROWN, T. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY 1, 1897.

		Date of election.
ABBE, CLEVELAND	*Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*Army Building, New York City.*	1872
AGASSIZ, ALEXANDER	*Cambridge, Mass.*	1866
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	*3909 Locust st., Philadelphia, Pa.*	1876
BARUS, CARL	*Providence, R. I.*	1892
BELL, A. GRAHAM	*Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*32 E. Thirty-first st., New York.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	*16 Craigie st., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*Army Building, New York City.*	1884
COPE, EDWARD D	*2100 Pine st., Philadelphia, Pa.*	1872
COUES, ELLIOTT	*Washington, D. C.*	1877
CRAFTS, JAMES M	*59 Malborough st., Boston, Mass.*	1872
DANA, EDWARD S	*New Haven, Conn.*	1884
DAVIDSON, GEORGE	*San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Washington, D. C.*	1884
ELKIN, WILLIAM L	*New Haven, Conn.*	1895
EMMONS, SAMUEL F	*Washington, D. C.*	1892
FARLOW, W. G	*Cambridge, Mass.*	1879
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883

		Date of election.
GILL, THEODORE N	*Washington, D. C.*	1873
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH	*Washington, D. C.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*West Nyack, N. Y.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*San Jose, Cal.*	1885
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*New Haven, Conn.*	1866
KING, CLARENCE	*Century Club, New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LEA, M. CAREY	*430 Walnut St., Philadelphia, Pa.*	1892
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LESLEY, J. PETER	*1008 Clinton St., Philadelphia, Pa.*	——
MARSH, O. C	*New Haven, Conn.*	1874
MAYER, ALFRED M	*Hoboken, N. J.*	1872
MAYO-SMITH, RICHMOND	*Columbia College, New York City.*	1890
MENDENHALL, THOMAS C	*Worcester, Mass.*	1887
MICHAEL, ARTHUR	*Somerville, Mass.*	1889
MICHELSON, ALBERT A	*Chicago, Ill.*	1888
MITCHELL, HENRY	*18 Hawthorne St., Boston, Mass.*	1885
MITCHELL, S. WEIR	*1524 Walnut St., Philadelphia, Pa.*	1865
MORSE, EDWARD S	*Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWCOMB, SIMON, U. S. N	*Washington, D. C.*	1869
PACKARD, A. S	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*Milford, Pa.*	1877
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs Ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	*147 S. Fourth St., Philadelphia, Pa.*	——
ROGERS, WILLIAM A	*Waterville, Me.*	1885
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
SARGENT, CHARLES S	*Jamaica Plain, Mass.*	1895
SCHOTT, CHARLES A	*Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	*1600 Hamilton St., Philadelphia, Pa.*	1873
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
TRUMBULL, J. H	*Hartford, Conn.*	1872
VERRILL, A. E	*New Haven, Conn.*	1872
WALKER, FRANCIS A	*Boston, Mass.*	1878
WELCH, WILLIAM H	*Baltimore, Md.*	1895
WHITE, CHARLES A	*Washington, D. C.*	1889
WHITMAN, CHARLES O	*Chicago, Ill.*	1895
WOOD, HORATIO C	*1925 Chestnut St., Philadelphia, Pa.*	1879
WRIGHT, ARTHUR W	New Haven, Conn.	1881
YOUNG, CHARLES A	Princeton, N. J.	1871

HONORARY MEMBER.

LYMAN, THEODORE ..... *Brookline, Mass.*

DECEASED MEMBERS.

	Date of death.
*AGASSIZ, LOUIS	Dec. 14, 1873
*ALEXANDER, J. H	Mar. 2, 1867
*ALEXANDER, STEPHEN	June 25, 1883
*BACHE, ALEXANDER DALLAS	Feb. 14, 1867
*BAIRD, SPENCER F	Aug. 19, 1887
BARNARD, F. A. P	Apr. 27, 1889
BARNARD, J. G	May 14, 1882
BARTLETT, W. H. C	Feb. 11, 1893
*BROWN-SEQUARD, CHARLES E	Apr. 2, 1894
CASEY, THOMAS L., U. S. A	Mar. 25, 1896
*CASWELL, ALEXIS	Jan. 8, 1887
*CHAUVENET, WILLIAM	Dec. 13, 1870
*CLARK, HENRY JAMES	July 1, 1873
*COFFIN, JAMES H	Jan. 6, 1873
COFFIN, J. H. C	Jan. 8, 1890
*COOK, GEORGE H	Sept. 22, 1889
COOKE, JOSIAH P	Sept. 3, 1894
*DALTON, J. C	Feb. 2, 1889
DANA, JAMES D	Apr. 14, 1895
*DAVIS, CHARLES H	Feb. 18, 1877
*DRAPER, HENRY	Nov. 20, 1882
*DRAPER, JOHN W	Jan. 4, 1882
*EADS, JAMES B	Mar. 8, 1887
*ENGELMANN, GEORGE	Feb. 4, 1884
*FERREL, WILLIAM	Sept. 18, 1891
*FRAZER, JOHN FRIES	Oct. 12, 1872
*GABB, WILLIAM M	May 30, 1878
GENTH, F. A	Feb. 2, 1893
*GILLISS, JAMES MELVILLE	Feb. 9, 1865
GOODE, G. BROWN	Sept. 6, 1896
*GOULD, AUGUSTUS A	Sept. 15, 1866
GOULD, BENJAMIN A	Nov. 27, 1896
*GRAY, ASA	Jan. 30, 1888
*GUYOT, ARNOLD	Feb. 8, 1884
*HADLEY, JAMES	Aug. 1, 1864
*HALDEMAN, S. S	Sept. 20, 1880
*HAYDEN, F. V	Dec. 22, 1887
*HENRY, JOSEPH	May 13, 1878
*HILGARD, JULIUS E	May 8, 1891
*HITCHCOCK, EDWARD	Feb. 27, 1864
*HOLBROOK, J. E	Sept. 8, 1871
*HUBBARD, J. S	Aug. 16, 1863
*HUMPHREYS, A. A	Nov. 28, 1883
HUNT, T. STERRY	Feb. 12, 1892
*KIRKLAND, JARED P	Dec. 10, 1877
*LANE, J. HOMER	May 3, 1880
*LE CONTE, JOHN	Apr. 29, 1891
*LE CONTE, JOHN L	Nov. 15, 1883
LEIDY, JOSEPH	Apr. 30, 1891
*LESQUEREUX, LEO	Oct. 25, 1889
LONGSTRETH, MIERS F	Dec. 27, 1891
*LOOMIS, ELIAS	Aug. 16, 1889

*Biographical notices have been presented of those designated by an asterisk.

	Date of death.
LOVERING, JOSEPH	Jan. 18, 1892
*MAHAN, D. H	Sept. 16, 1871
*MARSH, G. P	July 23, 1882
*MEEK, F. B	Dec. 21, 1877
*MEIGS, M. C	Jan. 2, 1892
*MORGAN, LEWIS H	Dec. 14, 1881
NEWBERRY, J. S	Dec. 7, 1892
NEWTON, H. A	Aug. 1, 1896
NEWTON, JOHN	May 1, 1895
*NORTON, WILLIAM A	Sept. 21, 1883
*OLIVER, JAMES E	Mar. 27, 1895
PETERS, C. H. F	July 18, 1890
*POURTALES, L. F	July 19, 1880
RODGERS, JOHN	May 5, 1882
ROGERS, ROBERT E	Sept. 7, 1884
*ROGERS, WILLIAM B	May 30, 1882
*RUTHERFURD, LEWIS M	May 30, 1892
*SAXTON, JOSEPH	Oct. 26, 1873
*SILLIMAN, BENJ., Sr	Nov. 24, 1864
SILLIMAN, BENJ., Jr	Jan. 14, 1885
*SMITH, J. LAWRENCE	Oct. 12, 1883
*STIMPSON, WILLIAM	May 26, 1873
*STRONG, THEODORE	Feb. 1, 1869
*SULLIVANT, W. S	Apr. 30, 1873
*TORREY, JOHN	Mar. 10, 1873
*TOTTEN, J. G	Apr. 22, 1864
*TROWBRIDGE, WILLIAM P	Aug. 12, 1892
*TUCKERMAN, EDWARD	Mar. 15, 1886
*WARREN, G. K	Aug. 8, 1882
*WATSON, JAMES C	Nov. 23, 1880
*WATSON, SERENO	Mar. 9, 1892
*WINLOCK, JOSEPH	June 11, 1875
*WOODWARD, J. J., U. S. A	Aug. 17, 1884
*WORTHEN, A. H	May 6, 1888
*WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

BUNSEN, ROBERT W	*Heidelberg.*
STRUVE, OTTO VON	*Pulkowa.*
STOKES, SIR GEORGE G	*Cambridge.*
SYLVESTER, J. J	*Oxford.*
HOOKER, SIR J. D	*Kew.*
LORD KELVIN	*Glasgow.*
AUWERS, ARTHUR	*Berlin.*
BERTRAND, J. L. F	*Paris.*
VIRCHOW, RUDOLPH VON	*Berlin.*
BERTHELOT, M. P. E	*Paris.*
KÖLLIKER, ALBERT VON	*Würzburg.*
RICHTHOFEN, F. VON	*Berlin.*
GEGENBAUR, CARL	*Heidelberg.*
WEIERSTRASS, KARL	*Berlin.*
RAMMELSBERG, K. F	*Berlin.*
LEUCKART, RUDOLPH	*Leipsic.*
SACHS, JULIUS VON	*Würzburg.*
LIE, SOPHUS	Leipsic.

*Biographical notices have been presented of those designated by an asterisk.

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.
CARL ERNST VON BAER.
HENRY MILNE-EDWARDS.
MICHAEL FARADAY.
L. ELIE DE BEAUMONT.
SIR DAVID BREWSTER.
G. A. A. PLANA.
F. W. A. ARGELANDER.
FRIEDRICH WÖHLER.
J. B. DUMAS.
J. B. J. D. BOUSSINGAULT.
M. E. CHEVREUL.
MICHEL CHASLES.
SIR GEORGE B. AIRY.
J. C. ADAMS.
SIR RICHARD OWEN.
C. H. C. BURMEISTER.
ARTHUR CAYLEY.
T. H. HUXLEY.
HUGO GYLDÉN.
F. F. TISSERAND.
SIR RODERICK I. MURCHISON.
VICTOR REGNAULT.
H. W. DOVE.
C. A. F. PETERS.
JUSTUS VON LIEBIG.
ALEXANDER BRAUN.
JOACHIM BARRANDE.
ADOLPHE WÜRTZ.
THEODORE VON OPPOLZER.
G. R. KIRCHOFF.
RUDOLPH CLAUSIUS.
JAMES P. JOULE.
CARLOS IBAÑEZ.
JEAN SERVAIS STAS.
ALPHONSE DE CANDOLLE.
A. W. HOFMANN.
BARON H. VON HELMHOLTZ.
K. F. W. LUDWIG.
LOUIS PASTEUR.
AUGUST KEKULÉ.
EMIL DU BOIS REYMOND.

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1897.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1898.

LETTER

FROM THE

PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES,

TRANSMITTING

A REPORT OF THE OPERATIONS OF THE NATIONAL ACADEMY OF SCIENCES DURING THE YEAR 1897.

JANUARY 13, 1898.—Ordered to be printed.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 1, 1898.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences for the past year.

Very respectfully,

WOLCOTT GIBBS,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

ACT OF INCORPORATION.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own

organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 24, 1884.*

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

SESSIONS OF THE NATIONAL ACADEMY.

During the year 1897 the Academy held three sessions. The first was the regular annual session, held at Washington, April 20 to 22, inclusive. The second was a scientific session, held at Boston, November 16 to 18. The third, a special session, held at Boston, November 17, for the transaction of business.

ANNUAL MEETING.

[Held at Washington, April 20 to 22, 1897.]

The session was held in the National Museum, the president, Mr. Wolcott Gibbs, presiding.

The following-named members were present during the session: Abbe, Abbott, Agassiz, Barker, Billings, Bowditch, Brewer, Brooke, Brush, Chandler (S. C.), Comstock, Crafts, Emmons, Gibbs (W.), Gilbert, Gill, Hayne, Hall (A.), Hastings, Hill (S. W.), Hyatt, Langley, Marsh, Mendenhall, Michelson, Morse, Newcomb, Powell, Putnam, Remsen, Rowland, Walcott, Wright.

The home secretary made no formal report, but stated that the first memoir of Vol. VIII of the Memoirs of the Academy had been printed.

The president's report was as follows:

Since the publication of my annual report to Congress, which dates January 1, 1897, no new business from Congress or from the Departments has required the attention of the Academy. The forestry commission will, as I am informed, hand in its final report on or about the 1st of May next. This report will, of course, be entered upon the records of the Academy and a copy of it sent to the Secretary of the Interior. On the 1st of February last I transmitted to the Hon. David R. Francis, Secretary of the Interior, a preliminary report by the chairman of the forestry commission, Prof. C. S. Sargent.

The President of the United States* adopted the recommendations of the commission, and on the 22d of February issued thirteen procla-

*Mr. Cleveland.

mations establishing the reservations which the commission had recommended.

On April 5 the commission, at the request of the Secretary of the Interior, addressed him briefly, outlining the character of the recommendations.

A report from Prof. T. N. Gill, appointed to represent the Academy at the International Zoological Congress, will not be expected until after the meeting of that body in 1898.

No action has been taken by Congress upon the subject of vivisection, upon which the opinion of the Academy was expressed at the April meeting in 1896, and transmitted to Senator Gallinger.

REPORT OF THE TREASURER.

WASHINGTON, D. C., *April 20, 1897.*

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES:

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 20, 1897:

Income.	General fund.	Bache fund.	Watson fund.	Draper fund.	J. Lawrence Smith fund.	Gibbs fund.
To balance brought forward:						
Cash	$306.08	$5,223.72	$1,266.52	$823.77	$1,004.73	.....
Invested	*a* 500.00	.....	*a* 500.00 *b* 593.71	.....	*c* 596.57	.....
Interest received during 1896-97	18.26	2,527.12	1,157.22	428.20	444.40	$133.66
Received from members' tax	375.00	.....	.....	.....	.....	.....
Total to be accounted for	1,199.34	7,750.84	3,517.45	1,251.97	2,045.70	133.66
Disbursed, 1896-97	375.65	3,475.39	983.35	10.01	13.30	133.66
Balance:						
Cash	323.69	3,275.45	1,440.39	1,241.96	1,435.83	.....
Invested	*a* 500.00	*d* 1,000.00	*a* 500.00 *b* 593.71	.....	*c* 596.57	.....
Total accounted for	1,199.34	7,750.84	3,517.45	1,251.97	2,045.70	133.66
Available (less obligations)	323.69	2,023.45	1,440.39	1,241.96	1,423.83	.....

a District of Columbia bonds, 3.65 per cent. *b* Earnshaw loan, 6 per cent.
c Webb loan, 5 per cent. *d* J. R. Dos Passos loan, 5 per cent.

The Dunlop loan has been extended to April 16, 1902.

The Stevens loan, $4,000, has been paid, and a new investment made by the purchase of the note of John R. Dos Passos for $5,000, the balance being a part of the income of the Bache fund.

There remains of the uninvested Watson fund $100, received last year by the calling in of one of the bonds of the Cosmos Club.

The treasurer's bond was renewed to June 30, 1897.

Very respectfully,

JOHN S. BILLINGS, *Treasurer.*

REPORT OF THE AUDITING COMMITTEE.

WASHINGTON, D. C., *April 20, 1897.*

The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances correspond to the vouchers and accounts of the treasurer and are found correct.

CHARLES S. HASTINGS.
SETH C. CHANDLER.

2017 I STREET NW., WASHINGTON, *April 20, 1897.*

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: The committee appointed by you to examine the securities of the Academy in the hands of the treasurer did so on April 13, and we have signed duplicate reports, one of which is in the books of the treasurer and the other is submitted herewith. The securities, receipts, and papers examined by us are in the lock box of the Academy at the building of the Washington Safe Deposit Company.

Very respectfully,

CLEVELAND ABBE,
On behalf of the chairman, Mr. Schott, who is ill.

PAPERS READ AT THE ANNUAL MEETING.

* I. The Influence of Environment upon the Biological Processes of the Various Members of the Colon Group of Bacilli. An Experimental Study. By Adelaide Ward Peckham, M. D. (Presented by J. S. Billings.)

* II. On the Energy Involved in Recent Earthquakes. T. C. Mendenhall.

† III. On a Ring Pendulum for Absolute Determinations of Gravity. T. C. Mendenhall and A. S. Kimball.

† IV. Biographical Memoir of G. Brown Goode. S. P. Langley.

† V. Biographical Memoir of Thomas L. Casey. H. L. Abbot.

† VI. Biographical Memoir of Charles E. Brown-Séquard. H. P. Bowditch.

† VII. Biographical Memoir of Hubert A. Newton. J. W. Gibbs.

† VIII. Biographical Memoir of George H. Cook. G. K. Gilbert.

† IX. On the Variation of Latitude. S. C. Chandler.

X. The Position of the Tarsiids and Relationship to the Phylogeny of Man. Theodore Gill.

XI. A New Harmonic Analyzer. A. A. Michelson and S. W. Stratton.

XII. Variation of Latitude and Constant of Aberration from Observations at Columbia University. By J. K. Rees, H. Jacoby, and H. S. Davis. (Presented by S. C. Chandler.)

* Read April 20. † Read April 21.

XIII. On Recent Borings in Coral Reefs. A. Agassiz.

XIV. Notes of Experiments upon the Röntgen Rays. Arthur W. Wright.

ELECTION OF NEW MEMBERS.

Four new members were elected at this session, William H. Dall, of Washington, D. C.; Francis A. Gooch, of New Haven; Charles S. Minot, of Boston, and Edward W. Morley, of Cleveland, Ohio.

During the year the Academy lost by death Mr. Francis A. Walker, Mr. Theodore Lyman, Mr. Alfred M. Mayer, and Mr. James Hammond Trumbull.

REPORTS FROM TRUST FUNDS FOR THE YEAR ENDING JANUARY 1, 1898.

Mr. Wolcott Gibbs reported that during the year 1897 the following appropriations have been made from the Bache fund:

March 18: To Prof. A. S. Packard, for an investigation of the transformations of North American bombycine moths	$100
March 29: To Prof. R. H. Chittenden, for an investigation of the poisonous fungi or toadstools of the country	500
April 29: To Prof. Albert A. Michelson, for the construction of a new harmonic analyzer and integrator	400
May 1: To Dr. John S. Billings, for an investigation of the colon bacillus group of organisms, being a continuation of the research upon the variability of bacteria, previously appropriated from the Bache fund	500
May 5: To Prof. A. A. Michelson, for an investigation of a two-decimeter standard of length, which is to be determined in terms of the wave lengths of red cadmium radiations by the interference method	
May 17: To Prof. Ira Remsen, for an investigation of the atomic weight of cadmium	400
May 22: To Alexander Agassiz for assistance in paying part of the expenses of borings to be made in the Fiji Islands to determine the thickness of coral reefs	1,200
December 7: To Prof. A. S. Packard for an investigation of the metamorphoses of the bombycine moths, in continuation of work already published in the last volume of Memoirs of the National Academy	100

SCIENTIFIC SESSION.

[Held in Boston, November 16 and 18, 1897.]

A scientific session for the reading of papers only having been called by the council, the Academy met at the Institute of Technology, Boston. The president, Mr. Wolcott Gibbs, presided.

The following named members were present during the session: Barker, Barus, Boss, Bowditch, Brewer, Brush, Chandler, C. F., Chandler, S. C., Chittenden, Comstock, Crafts, Emmons, Farlow, Gibbs, W., Goodale, Hague, Hall, A., Hastings, Hill, H. B., Hyatt, Jackson, Lesley, Marsh, Mendenhall, Michelson, Minot, Mitchell, H., Morse, Packard, Pickering, Powell, Putnam, Rogers, W. A., Sargent, Verrill, *Woodward, Minot*—36.

The following papers were read:

A lecture at the Jefferson Physical Laboratory, Cambridge, on Electrical Discharges, with exhibition of apparatus for obtaining high voltages, at 8 p. m., November 17, by John Trowbridge.

I. The Mass of the Earth's Atmosphere. R. S. Woodward.

II. On a Final Determination of the Relative Lengths of the Imperial Yard and of the Meter of the International Bureau. W. A. Rogers.

III. The Secular Softening of Cold Hard Steel. C. Barus.

IV. On the Elastic Resistance of Steel Knife Edges. T. C. Mendenhall.

V. Evolution and Migrations of Land Shells on Hawaiian Islands. A. Hyatt.

VI. The Influence of Borax and Boric Acid on Nutrition. R. H. Chittenden.

VII. Embryological Observations. C. S. Minot.

*VIII. On a New Method of obtaining Derivatives of Guanidine. Ira Remsen.

*IX. On the Boiling Points of Mixtures of Benzene and Alcohols. Ira Remsen.

*X. On Double Halides Containing Organic Bases. Ira Remsen.

XI. Results obtained with a new Harmonic Analyzer. A. A. Michelson and S. W. Stratton.

XII. On the Ancient Molluscan Fauna of New England. E. S. Morse.

XIII. On a new Application of the Wave Siren. C. R. Cross.

XIV. New Apparatus for the Comparison of Thermometers and for the Determination of the Heat of Combustion of Fuels. C. L. Norton.

XV. Recent Observations on European Dinosaurs. O. C. Marsh.

XVI. The Jurassic Formation of the Atlantic Coast—Supplement. O. C. Marsh.

XVII. Ovarian Variations and Cannibalistic Selection as Factors in the Evolution of Species. A. E. Verrill.

XVIII. Notable Instances of Free Variation nearly unchecked by Natural Selection. A. E. Verrill.

XIX. Some of the Important Factors in the Evolution of the Marine Animals of Coral-Reef Seas. A. E. Verrill.

XX. Comparison of the Theory of the Motion of the Pole with recent Observations. S. C. Chandler.

XXI. An Hypothesis to account for Movements in the Crust of the Earth. J. W. Powell.

XXII. A Contribution to the Study of the Action of the Venom of the Crotalus Adamanteus upon the Blood. S. Weir Mitchell, M. D., and Alonzo H. Stewart, M. D.

XXIII. Mr. S. F. Emmons gave an informal account of the recent Geological Convention at St. Petersburg.

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*Read by title only.

BUSINESS MEETING.

A business meeting of the Academy called by the council to consider the report of the president to Congress and such other business as might be presented was held November 17. The president, Mr. Wolcott Gibbs, presided.

The Academy was called to order by the president at 11 a. m. The following-named members were present: Barker, Barus, Boss, Bowditch, Brewer, Brush, Chandler (S. C.), Chittenden, Comstock, Crafts, Emmons, Farlow, Gibbs (W.), Hall (A.), Hastings, Hill (H. B.), Hyatt, Jackson, Marsh, Mendenhall, Minot, Michelson, Mitchell (H.), Morse, Packard, Rogers (W. A.), Verrill, Woodward.

After the call of the roll the president presented an outline of his report to Congress for the year 1897. Upon the recommendation of the council the Academy authorized the president to present his report to Congress, and to include in it the proceedings of the present meeting and also any Government business which may come before the Academy.

The president then announced that Miss Alice Bache Gould, daughter of the distinguished astronomer, Benjamin Apthorp Gould, had presented to the Academy the sum of $20,000 as a memorial of the life work of her father. The terms of the donation are stated in the two accompanying papers, one of which is the deed of trust, and the other a detailed expression of the preference of the donor as regards the administration of the trust. The president then read the two papers to the Academy.

DEED OF TRUST FROM ALICE BACHE GOULD, OF BOSTON, MASS., TO THE NATIONAL ACADEMY OF SCIENCES.

Know all men by these presents that I, Alice Bache Gould, of the city of Boston and county of Suffolk, State of Massachusetts, in consideration of the acceptance of the within trust by the National Academy of Sciences, and also in consideration of divers other good and valuable considerations, have given, granted, assigned, transferred, and set over, and by these presents do give, grant, assign, transfer, and set over unto the said National Academy of Sciences and its successors forever a certain fund or sum of $20,000, with the interest and income thereof, to have and to hold the same in trust nevertheless upon the special trusts and for the uses and purposes following, to wit:

First. In trust to invest and reinvest the said sum of $20,000, and to keep the same invested under the ordinary rules governing trustees in good and safe securities in such manner as shall be deemed best for the preservation and maintenance of such fund, which shall be known as the Benjamin Apthorp Gould fund, in memory of my father, the late Benjamin Apthorp Gould, of Cambridge, Mass.

Second. In trust to use the net interest and income thereof according to and under the direction of Lewis Boss, of Albany, N. Y., Seth C. Chandler, of Cambridge, Mass., and Asaph Hall, of Washington, D. C., whom I hereby constitute a board of directors for the application of the income of the said Benjamin Apthorp Gould fund, for the prosecution of researches in astronomy, by assisting such observers and investigators in such manner and in such sums as shall be agreed upon by the three above-mentioned persons or their successors or by a majority of the then board.

The board of directors, however, instead of expending all the income of the fund for the purposes aforesaid, may, from time to time, vote that such portions thereof as they may prescribe shall be added to the principal of said fund, and such portion shall then be so added by the trustees, and all such sums once so added shall remain part of the principal.

The board of directors shall make an annual report to the National Academy of Sciences, giving such information concerning the fund as shall be desired by the said Academy.

In case of any vacancy occurring in the board of directors by reason of the death, inability or refusal to act, or resignation of any of its members, then the surviving or remaining members or member for the time being shall have power to fill any vacancy so occurring in the board by the selection of another person or persons to fill the same, and so on from time to time as vacancies shall occur, provided, however, that at least two of the three directors shall always be members of the National Academy of Sciences. But if at any time the three directorships of the board shall simultaneously be vacant, then the National Academy of Sciences shall have power to fill these vacancies, and the new board of directors, in this as in all other cases, shall succeed to all the rights, duties, and privileges of the former board.

Provided, however, that if at any time the said Academy, from any cause whatever, shall cease to exist, or in case at any time any modification of its rights or powers shall be made by any action other than that of the said Academy itself, and such modification shall be followed within six months thereafter by a vote of the then board of directors approving the passing and transfer hereinafter mentioned, then, and in all of such cases, the said fund, together with all accumulations and unexpended income thereof, shall pass and be transferred to the said board of directors, who shall thereafter exercise the functions of both directors and trustees, and the said National Academy shall no longer thereafter act as trustee, and shall have no power of appointing directors, and none of the directors need be members of the said National Academy; and, furthermore, after such transfer and passing the said directors may at any time appoint any other persons or corporation as trustees, reserving to themselves their powers and duties

as directors, and the fund shall thereupon pass to such new trustees to be held upon the same trusts upon which it is hereby given to the National Academy of Sciences, the principal, with its accumulations, to be always held intact and the income applied as shall be best for the advancement of astronomy and for the honor of my father's memory.

And the said National Academy of Sciences doth hereby signify its acceptance of the said fund of $20,000, and doth engage to hold the same upon the trusts and conditions and for the uses and purposes herein mentioned and set forth.

In witness whereof I, the said Alice Bache Gould, have hereto set my hand and seal, and the said National Academy of Sciences has caused its corporate name and seal to be hereto affixed by Wolcott Gibbs, its president, thereunto duly authorized, this 17th day of November, in the year 1897.

ALICE BACHE GOULD. [SEAL.]
WOLCOTT GIBBS, [SEAL.]
President of the National Academy of Sciences.

W. W. VAUGHN, witness to Alice Bache Gould.
O. C. MARSH, witness to Wolcott Gibbs.
J. M. CRAFTS, witness to Wolcott Gibbs.
C. B. COMSTOCK, witness to Wolcott Gibbs.

We hereby accept our appointment to the board of directors above constituted.

LEWIS BOSS. [SEAL.]
SETH C. CHANDLER. [SEAL.]
ASAPH HALL. [SEAL.]

Witnesses for directors:
GEORGE F. BARKER.
EDW. S. MORSE.
HENRY B. HILL.

Whereupon it was duly—

Voted, That the National Academy of Sciences accepts the gift and trust set forth in said deed; and

Voted, That in token thereof the president, Wolcott Gibbs, be, and he hereby is, authorized and empowered to affix the name and seal of the National Academy of Sciences to the original trust deed aforesaid.

The Board of Directors of the Benjamin Apthorp Gould Fund.

GENTLEMEN: Believing that elaborate legal restrictions upon the uses of a perpetual fund may often, under changing circumstances, hinder the accomplishment of the general intention of the donor, I have in the deed creating the Benjamin Apthorp Gould fund defined its uses as briefly as possible, namely, as "for the prosecution of researches in astronomy."

Nevertheless, I wish hereby to record with you some personal preferences based upon what I believe would have been my father's opinions regarding the best use of such a fund, expressly stating, however, that this letter is not intended to restrict the action of the board of directors more than shall in their judgment be expedient and fitting.

First. My object in creating the fund is twofold—on the one hand to advance the science of astronomy, and on the other to honor my father's memory and to insure that his power to accomplish scientific work shall not end with his own life.

Second. Throughout my father's lifetime his patriotic feeling and scientific ambition were closely associated, and I wish, therefore, that a fund bearing his name should be used, primarily, for the benefit of investigators in his own country or of his own nationality. I recognize, however, that sometimes the best possible service to American science is the maintenance of close communion between the scientific men of Europe and of America, and that, therefore, even while acting in the spirit of the above restriction, it may occasionally be best to apply the money to the aid of a foreign investigator working abroad.

In this connection I must also refer to the strong interest felt by my father in the National Academy of Sciences, and to his belief in the importance of creating and maintaining a single national scientific body, whose preeminence should be unquestionable and of concentrating power in its hands. I wish to recommend that all three directors shall be members of the Academy, although I have made this legally necessary for only two of the three, and to record the desire to serve the Academy, so far as I am able, as one of my minor motives in creating the trust.

Third. I have copied many of the provisions of the Bache fund, and it is my hope that the boards of direction of the two funds may always act in friendly unison, as befits the long and intimate friendship of the men whose work they perpetuate. I trust that the new fund may relieve the Bache directors of many astronomical expenses and thus enable them to devote the same amounts of money to other branches of science. And I recommend the adoption of a custom now followed by the Bache board of directors, by which each director upon his own election names to his colleagues the person whom he believes most fit to succeed him.

Fourth. I wish that in all cases work in the astronomy of precision should be distinctly preferred to any work in astrophysics, both because of my father's personal preference and because of the present existence of generous endowments for astrophysics.

Fifth. The Astronomical Journal, long conducted by my father, has, in my belief, exerted a powerful influence in raising the standard of American astronomy, and in case at some future time its existence should be imperiled by lack of funds, I wish to recommend it to the attention of the then board of directors. As, however, I believe that

the granting to any scientific journal of definite rights over such a fund would be a dangerous precedent, I here repeat that the directors are not to consider themselves bound by these my present wishes further than they deem appropriate in connection with a journal associated with my father's name.

Sixth. The Benjamin Apthorp Gould fund is intended for the advancement and not for the diffusion of scientific knowledge. Moreover, I prefer that it should be used to defray the actual expenses of an investigation rather than for the personal support of the investigator during the time of his researches. I do not wish absolutely to exclude the latter important use, but such an employment of funds seems to me more appropriately the function of a university than of the National Academy, and I hope, therefore, that before granting money for such a purpose the directors will consider the existing university endowments and other sources of pecuniary aid for able workers in science.

Finally, I wish to express my entire faith in the wise judgment of the first board of directors and my sense of my own good fortune in being able to intrust a memorial of my father to the hands of men who have been both his scientific associates and his intimate personal friends.

ALICE BACHE GOULD.

BOSTON, *November 17, 1897.*

The deed of trust was then formally accepted by the Academy by a unanimous vote, and the three directors under the trust formally accepted their appointment.

The Academy then by a unanimous vote requested the president to prepare a letter of acknowledgment to be engrossed and sent to Miss Gould.

The Academy then adjourned to meet at Washington on the third Tuesday in April, 1898.

BUSINESS FROM CONGRESS AND FROM DEPARTMENTS OF THE GOVERNMENT.

Since the April session no new business from the Government has required the attention of the Academy, but the following documents relating to the Forestry Commission have appeared since the publication of the report of the president for the year 1896:

LETTER OF THE SECRETARY OF THE INTERIOR TO THE PRESIDENT, TRANSMITTING A REPORT BY THE NATIONAL FORESTRY COMMISSION TO THE NATIONAL ACADEMY OF SCIENCES, RECOMMENDING THE ESTABLISHMENT OF ADDITIONAL FOREST RESERVATIONS.

DEPARTMENT OF THE INTERIOR,
Washington, D. C., February 6, 1897.

The PRESIDENT:

An appropriation of $25,000 was made in the sundry civil bill approved June 11, 1896 (29 Stat. L., 432), "to enable the Secretary of

the Interior to meet the expenses of an investigation and report by the National Academy of Sciences on the inauguration of a national forestry policy for the forested lands of the United States." Under authority of this act, and with the approval of the Secretary of the Interior, Prof. Wolcott Gibbs, president of the National Academy of Sciences, appointed a commission consisting of Prof. Charles S. Sargent, director of the Arnold Arboretum at Harvard University; Gen. Henry L. Abbott, United States Engineer Corps; Prof. William H. Brewer, of Yale University; Mr. Arnold Hague, of the United States Geological Survey; Mr. Alexander Agassiz, and Mr. Gifford Pinchot, the president of the Academy being ex officio a member of the commission. The state of Professor Gibbs' health would not permit him to accompany the commission on its tour of inspection, but the other members began their work July 2, 1896, and visited most or all of the forest reservations and other public forests of the United States, devoting three months of hard travel and careful study, without compensation, to the work assigned them. Upon their return they made an informal report to me, whereupon one or more competent clerks in the General Land Office, familiar with its records, were detailed to assist in the preparation of their report, which was completed and submitted about February 1.

I have the honor to forward said report herewith, and respectfully and earnestly approve the recommendations therein.

You will observe that the report recommends the establishment of thirteen additional forest reservations, containing an aggregate area of 21,379,840 acres. The location and limits of the proposed reservations are shown on the accompanying maps, and the report of the commission gives strong reasons for the establishment thereof. The amount of land in each reservation already entered under the general land laws is insignificant, and is set forth in accordance with the latest data in the General Land Office, and those portions of the areas described are exempted from the operation of the Executive order requested.

Some of the reservations proposed are within the limits of railroad grants hitherto made by Congress, and in such cases an Executive proclamation only reserves the alternate sections. This is notably the case in No. 6, the Priest River forest reserve, which the report of the commission characterizes as "the most valuable body of timber in the interior of the continent." If you decide to make this Executive order, I shall prepare and submit to Congress a bill authorizing the Secretary of the Interior to indemnify the beneficiaries in any of these railroad land grants included within the limits of forest reservations established by proclamation of the President by patenting to them an equal quantity of other portions of the public domain within specified limits.

The commission, which is composed of men of ability, possessed of scientific attainments which peculiarly fit them for this work, has performed this responsible duty with intelligent fidelity.

The authority for establishing these reservations may be found in

section 24 of an act approved March 3, 1891 (26 Stat. L., 1103), "An act to repeal the timber-culture laws, and for other purposes." It provides—

That the President of the United States may from time to time set apart and reserve in any State or Territory having public land bearing forests, in any part of the public lands, wholly or in part covered with timber or undergrowth, whether of commercial value or not, as public reservations, and the President shall, by public proclamation, declare the establishment of such reservations and the limits thereof.

Under this law sixteen forest reservations have been established, aggregating an area of 17,500,000 acres. No forest reservation has been established by the President since September 28, 1893. The total area of the reservations hereby proposed exceeds that of all those heretofore established by about 4,000,000 acres, but as our public forests are being rapidly denuded and the loss resulting therefrom is incalculable I do not think this apparently large area should militate in any degree against the recommendation of the commission.

I respectfully suggest that the one hundred and sixty-fifth anniversary (February 22, 1897) of the birth of the Father of our Country could be no more appropriately commemorated than by the promulgation by yourself of proclamations establishing these grand forest reservations.

Very respectfully,

D. R. FRANCIS, *Secretary.*

FEBRUARY 1, 1897.

SIR: I have the honor to transmit for your consideration the inclosed letter from the chairman of the forestry commission of the National Academy of Sciences in relation to the establishment by proclamation of the President of the United States of a number of forest reservations.

Very respectfully, your obedient servant,

WOLCOTT GIBBS,
President of the National Academy of Sciences.

Hon. DAVID R. FRANCIS,
Secretary of the Interior.

ARNOLD ARBORETUM, HARVARD UNIVERSITY,
Jamaica Plain, Mass., February 1, 1897.

Prof. WOLCOTT GIBBS,
President of the National Academy of Sciences.

SIR: The commission appointed by you last year, at the request of the Secretary of the Interior, to examine the forests on the public domain and prepare a plan for their care now recommends the establishment of the following forest reserves:

1. THE BLACK HILLS RESERVE.

This proposed reserve embraces the central portion of the Black Hills of South Dakota, and has an established area of 967,680 acres.

The mountains in this proposed reserve are covered with forests of yellow pine, and in the valleys between them spruces and cottonwoods principally occupy the ground. These forests are entirely isolated, and afford the only timber which is produced in the territory between Minnesota on the east and the Big Horn Mountains of Wyoming and the Rocky Mountains on the west. The region immediately north of the proposed reserve contains a number of mines which depend on these forests for timber and fuel, and the settlers in the valleys of streams flowing from them have no other local timber and fuel supply. It appears important, therefore, that these forests should be protected and made permanently productive, and that they should continue to guard the sources of the numerous streams which head in the Black Hills and are essential for the irrigation of the desert region adjacent to their courses. The forests on this proposed reserve have suffered seriously from fire and the illegal cutting of timber, the mines in this whole region having been practically supplied with timber and fuel taken from the public domain. It is evident that without Government protection these forests, so far as their productive capacity is concerned, will disappear at the end of a few years, and that their destruction will entail serious injury and loss to the agricultural and mining population of western North and South Dakota. Within this proposed reserve there are thirteen quarter sections of land covered by existing entries, findings, selections, or other claims on record on the tract books in the General Land Office up to the 20th of January of the present year. These quarter sections are situated near the outside boundaries of the proposed reserve, and do not include the township sites of Custer and other small towns on the line of the northern extension of the Chicago, Burlington and Quincy Railroad, which crosses the proposed reserve from south to north.

2. THE BIG HORN RESERVE.

This proposed reserve has an estimated area of 1,198,080 acres and embraces both slopes of the Big Horn Mountains, a high, isolated, and exceedingly broken range in northern central Wyoming, containing a number of peaks varying from 9,000 to 11,000 feet in altitude, and the sources of many streams watering broad valleys east and west of these mountains. The forests which cover the Big Horn Mountains are composed of pines and spruces of small size. They contain sufficient material, nevertheless, to supply the local demands of agricultural settlers and of possible mining operations, but are not commercially valuable. These forests, however, protect the sources of many streams capable of irrigating a large territory which, without irrigation, can produce only scant and uncertain pasturage. The forests on the Big Horn Mountains have already suffered severely from fire. As the country becomes more settled fires may be expected to increase, and as forests reproduce themselves slowly in this dry climate their loss will reduce the irrigating capacity of these streams and the value of many valleys of central

Wyoming for agriculture. The proposed Big Horn Reserve contains only 15 quarter sections which are covered by existing entries, findings, selections, or other claims on record on the tract books in the General Land Office up to January 20 of the present year.

3. THE TETON FOREST RESERVE.

This proposed reserve embraces 829,440 acres, and is south of and adjacent to the Yellowstone Park Timber Land Reserve. The forests which cover it are similar in character to those in the Yellowstone National Park. They are capable of supplying all local demands that will probably ever be made on them, but have little commercial value. This proposed reserve contains the Teton Range of mountains and Jackson Lake and some of the grandest and most picturesque scenery of the Rocky Mountains. Within its borders are many streams flowing west, south, and north, and as a reservoir of moisture it is important. Incidentally it may be mentioned that the proposed reserve is a favorite home of the elk and other large game and that as a game reserve it would well supplement the Yellowstone National Park and the Yellowstone Park Timber Land Reserve. Within the proposed reserve only two quarter sections have been entered. A number of settlers, however, are living on unentered lands in the neighborhood of Jackson Lake.

4. THE FLATHEAD FOREST RESERVE.

This proposed reserve embraces both slopes of the main Rocky Mountain Range or continental divide in northern Montana, and extends from near the line of the Great Northern Railroad northward to the international boundary. It has an estimated area of 1,382,400 acres, and contains within its boundaries several high glacier-covered peaks, numerous lakes, and the sources of important streams. Nowhere in the United States is there more sublime mountain scenery. The eastern portion of this proposed reserve consists of lands recently purchased from the Blackfoot Indians under a treaty ratified by Congress on the 10th of June, 1896. The eastern slopes of the Rocky Mountains are here steep and rugged, and are mostly covered with dense forests of lodge pole pines and spruces which protect the sources of tributaries of the Missouri and the Saskatchawan, dependent entirely for their water on the snow which falls on these mountains, and protected by these forests. From these mountains issue the Cut Bank and Milk rivers, the latter, owing to its great length and the exceeding aridity of the country through which it flows, the most important stream of this region, although the Cut Bank supplies much of the water used by the Blackfoot Indians and by cattle men located east of the proposed reserve. North of Milk River flow, from the melting snow fields and glaciers at their sources, the St. Marys, Swift Current, and Belly rivers, the first passing into Canada after flowing 30 miles through the *territory* of the United States. This region, which is supposed to con-

tain many mineral deposits, will soon be invaded by large numbers of prospectors and miners, and its coniferous forests will invariably be injured, and perhaps destroyed, by the fires which have followed settlement from one end of the Rocky Mountains to the other. These forests are not commercially valuable in the sense that they contain timber which can be profitably shipped out of the region, but they can furnish sufficient forest products to carry on local mines and supply any agricultural population which may live on the streams in this part of Montana. If they are allowed to burn, mining operations will be crippled, and the settlers along these rivers will be deprived, during many months of every year, of water for themselves and their animals; for even now Milk River is only a sluggish stream through much of the year, and in periods of drought is reduced to a series of muddy water holes. In this proposed reserve west of the continental divide are the great north fork of Flat Head River and many of the smaller tributaries of that stream. The forests here, under the influence of a more humid climate, are much heavier than those on the eastern slopes of the Rocky Mountains, and are composed of a large number of varieties of trees; and here are stores of spruce, fir, tamarack, cedar, and cottonwood which in time can be made to play an important part in the development of Montana. These forests, too, in protecting the headwaters of turbulent mountain streams, reduce the damage of floods and render their fertile lower valleys habitable. In that part of this proposed reserve which is east of the continental divide there is now no settled land, but west of the continental divide two hundred and seventy-two quarter sections have been entered, as shown by the tract books in the General Land Office on the 20th of January of the present year; these entries are principally on the bottom lands of the north fork of the Flat Head River, where there are considerable bodies of arable land.

5. THE LEWIS AND CLARK FOREST RESERVE.

This proposed reserve embraces both slopes of the continental divide in Montana, and extends from near the line of the Great Northern Railroad southward nearly to the forty-seventh degree of north latitude. It has an estimated area of 2,926,080 acres, and includes an exceedingly rough mountainous territory, watered east of the divide by the north fork of the Sun River and west of the divide by the south fork of the Flat Head River, and by the Swan River, a large tributary of Flat Head Lake. The forests on the eastern slope of the Rocky Mountains are here similar in character to those in the eastern part of the proposed Flat Head Reserve; they protect the sources of innumerable streams tributary to the Missouri and essential to the existence of a considerable population residing on their banks and dependent on their waters for themselves and their stock. West of the continental divide the forests are heavier and are composed of yellow pines, lodge-pole pines, larches, Douglas spruces, balsam firs, and some white pines; these forests are

valuable for their influence on the flow of water in tributaries of the Columbia and for their timber, which can be easily floated into Flat Head Lake and then distributed by rail. In this proposed reserve there are no agricultural or grazing lands, and no evidence of valuable mineral deposits; and no land whatever has been legally settled on. The desirability of this forest reserve has been discussed for many years, and numerous petitions favoring it have been filed in the office of the Secretary of the Interior.

6. THE PRIEST RIVER FOREST RESERVE.

This proposed reserve occupies the basin of Priest Lake and Priest River, in the extreme northern part of Idaho and in northeastern Washington, and extends from a point a few miles north of the line of the Great Northern Railroad to the international boundary. It is bounded on the east by the summits of the ridges separating the waters flowing into Priest Lake from those tributary to the Kootenay River, and on the west by the summits of the ridges separating the waters of Priest Lake from those flowing into Clarks Fork of the Columbia. It has an estimated area of 552,960 acres in Idaho, and of 92,160 acres in Washington, or a total of 645,120 acres, and is covered with what is believed to be the most valuable body of timber in the interior of the continent. This is composed of the western white pine, which grows here to its largest size and in its greatest perfection; tamarack, cedar, spruce, all of large size. The forests on this proposed reserve have no significance as protectors of moisture, and the flow of rivers, for this region, is abundantly supplied with water, and its streams will always be able to meet any drain which may be made on them by the needs of irrigation. The establishment of this reserve is recommended, therefore, that this body of timber may be preserved until it is actually required by the demands of commerce, and that the Government may obtain for it its true market value. If scientific management of the forests on the reserves is ever attempted, the proposed Priest River Reserve, from the nature of its forest covering and the ease with which its timber can be marketed, will be found admirably suited for silvicultural experiments. No land in this proposed reserve has been entered, but it is covered by the land grant to the Northern Pacific Railroad.

7. THE BITTER ROOT FOREST RESERVE.

This proposed reserve includes a forest region of extremely precipitous and rugged mountains and lies on both sides of the boundary between Montana and Idaho; it contains an estimated area of 691,200 acres in Montana and of 3,456,000 acres in Idaho, or a total of 4,147,200 acres. From its eastern border the Bitter Root Mountains rise abruptly from the valley and are cut by the deep canyons of the streams which feed the Bitter Root River and make agriculture possible in the broad and *fertile Bitter Root* Valley. West of the summits of the Bitter Root

Range the proposed reserve includes some of the tributaries of the north fork of the Clearwater River, nearly the entire basin of the main Clearwater, and many of the tributaries of Salmon River, the waters of all the western part of the proposed reserve reaching the Columbia by way of Snake River. The eastern and western portions of the proposed reserve contain the sources of streams which can be used advantageously for purposes of irrigation; and the whole is covered with forests of yellow pine, lodge-pole pine, spruce, fir, and cedar. Portions of the reserve which lie in Montana are covered with forests of exceptionally large and valuable yellow pines, which are being rapidly cut without any pecuniary advantage to the Government. In Idaho, especially toward the southern part of the territory which it is proposed to reserve, and at high altitudes the forests are often separated by large burnt areas, many of them of ancient date; but no lumbering has been done and the whole region is remarkably rough and broken; it has no value for grazing except over a few small scattered areas, and the few deposits of valuable minerals known to exist within its borders are already exhausted. With proper protection the burnt areas will in time become covered with trees and the forests in this proposed reservation will be able to supply a large amount of material to the inhabitants of eastern Oregon and Washington, now one of the richest wheat-producing regions in the United States, and to the people of treeless southern Idaho. The region embraced in this proposed reserve appears to be the largest unsettled region in the United States, there being but three quarter sections of land entered in Idaho, while in Montana no entries have been made; few persons pass over its rough and difficult trails, and it can, therefore, be easily protected from fire.

8. THE WASHINGTON FOREST RESERVE.

This proposed reserve extends in Washington from about the one hundred and twentieth degree of west longitude to nearly the one hundred and twenty-second degree and from the international boundary southward to a little below the forty-eighth degree of latitude, the settled valley of the Skagit River being excluded in the west, and contains an estimated area of 3,594,240 acres. The region embraced in this proposed reserve extends over both slopes of the Cascade Mountains and is exceedingly broken and entirely clothed with forests. Those east of the Cascade divide have already suffered in places seriously from fire; they consist largely of yellow pine and are more open and less commercially valuable than those on the western slopes of the mountains, which are composed of spruces, firs, pines, cedars, and hemlocks of large size and of the first commercial value. Within this proposed reserve east of the Cascade summits are the sources of the Stehekin River, the principal feeder of Lake Chelan, and of the Methow River, a considerable northern tributary of the Columbia, and, like all the rivers of Washington, flowing eastward from the Cascade Range, important for the

irrigation of a region which needs only water to become exceptionally fertile. The forests in the eastern part of this proposed reserve should be preserved to protect the streams which head here; west of the Cascade summit for the timber which they contain. Only three quarter sections of land in this proposed reserve are covered by existing entries, findings, selections, or other claims on record on the tract books in the General Land Office up to the 20th of January of the present year, although there are a few settlers living on unentered lands on the Stehekin near the head of Lake Chelan, and a few others on a small tract of arable land in the valley of the Upper Methow. The territory in this proposed reserve is one of the most rugged, difficult, least known, and unsettled parts of the United States.

9. THE OLYMPIC FOREST RESERVE.

This proposed reserve occupies the high and broken Olympic Mountain region in northwestern Washington, and contains an estimated area of 2,188,800 acres. This is a region of steep and jagged mountains, their highest peaks clothed with glaciers and with perpetual snow. The forests here, watered by more copious rains than fall on any other part of the United States, are composed of enormous spruces, firs, and cedars, and in productiveness are surpassed in the world only by the redwood forests of the California Coast region. Few explorers have penetrated far into this region, which, from the denseness of its forest covering, offers exceptional difficulties to travel; and there is no record that it has been crossed in a north and south direction. This proposed reserve no doubt contains for its area the largest and most valuable body of timber belonging to the nation; and here is probably the only part of the United States where the forests unmarked by fire or the ax still exists over a great area in its primeval splendor. Toward the northwestern borders of the proposed reserve five hundred and fifty-two quarter sections of land appear to have been entered, principally under the provisions of the timber-claim law, but this entered land can not be readily excluded from the reserve without seriously complicating its boundaries, or without omitting a large body of unentered land which should properly belong to it. There is no agricultural or grazing land whatever in this proposed reserve and no traces of precious metals have yet been found in it. The character of its forests, which can be made to yield permanently vast quantities of timber, its wildness, the picturesqueness of its surface, and its remoteness make the proposed Olympic Reserve one of the most valuable of all the forest reserves which have been made or proposed.

10. THE MOUNT RAINIER FOREST RESERVE.

It is suggested that the existing Pacific Forest Reserve should be enlarged by the addition of a narrow strip of territory along its western *border, in order to* correct an error made when the boundaries of

this reserve were first laid down, and to make it thus include some of the salient features of Mount Rainier; that it should be extended southward along the two slopes of the Cascade Mountains nearly to the Columbia River, and the name Pacific Forest Reserve should be changed to Mount Rainier Forest Reserve. The name Pacific Forest Reserve is meaningless, and it is fitting that this reserve should bear the name of the great glacier-covered mountain, one of the highest, most beautiful, and interesting mountains in the United States, which is its chief natural feature. This was felt when the reserve was established, but to the people of Tacoma Mount Rainier is Mount Tacoma, and to avoid exciting local jealousies the Secretary of the Interior, at the last moment, adopted an inexpressive and inappropriate name. The mountain is now known officially in this country and by all foreign geographers as Mount Rainier, and is nowhere called Tacoma beyond the limits of the city of that name; and there seems no longer any reason why this reserve should not bear the name of Mount Rainier. The proposed extensions of this reserve contain an estimated area of 1,267,200 acres, which, with the 967,680 acres contained in the Pacific Forest Reserve, make a total of 2,234,880 acres. The preservation of the forests in the proposed southern extension will protect, east of the Cascade summits, the flow of several of the principal tributaries of the Yakima River, which furnishes the water for the most important system of irrigation in the State, and, west of the Cascade summits, timber of great commercial value. This whole region, which has suffered from fire and the unlawful pasturage of sheep, is practically unsurveyed and unsettled. One hundred and one quarter sections of land have, however, been entered upon within its boundaries. These are principally situated in the extreme southeastern corner, in the valley of the Little Salmon River. There are also a few settlers on tributaries of the Cowlitz River, close to the western borders of the proposed reserve.

11. THE STANISLAUS FOREST RESERVE.

This proposed reserve extends north over six townships along the summit of the Sierra Nevada Mountains in California, and embraces an estimated area of 691,200 acres. Many streams flowing east and west head in this territory and are fed by innumerable small lakes and alpine meadows. The forests, except in a few townships, are scanty and without value, except for preserving the flow of springs and streams; and the establishment of this reserve is recommended solely for the influence it can exert on the flow of Sierra rivers if its natural features are preserved. This region is now being injured by the illegal pasturing of sheep and by the fires which always follow the shepherd on the public domain, and its value as a water-storage basin is likely to be seriously impaired. For reasons which are not easy to explain, much of this high, rocky, timberless region has already been surveyed at the expense of the Government; 49 sections of land have already been entered, and 10 sections have been retained for reservoir sites.

12. THE SAN JACINTO FOREST RESERVE.

This proposed reserve embraces the San Jacinto Mountains in southern California, and is separated from the San Bernardino Forest Reserve by the San Gorgonio Pass. It contains an estimated area of 737,280 acres. The whole region, especially east of the mountains, is arid, and the lower slopes of the range, when not too steep, are clothed only with a bushy chapparal growth. Scanty forests of stunted conifers, however, exist on the sides of some of the canyons facing the ocean in the high valleys and on the elevated slopes, and the preservation of these forests seems essential that the mountain streams may supply water to irrigate the valleys of southwestern California, which without water are desert wastes, but irrigated bloom into the fairest orchards of the continent. Within this proposed reserve 421 quarter sections of land appear to have been already entered, as well as 29 quarter sections reserved for Indians. Much of this reserved land is in the San Jacinto Valley, where considerable timber has already been cut, and in Hermit Valley, where a large storage basin for irrigation has been built. This proposed reserve is covered by the land grant of the Southern Pacific Railroad. The people of southern California appear unanimous in their desire that this reserve should be made.

13. THE UINTAH FOREST RESERVE.

This proposed reserve embraces both slopes of the eastern part of the Uintah Mountain Range in northern Utah and the northern slope only of the western part of this range, the southern slope here being included in the Uintah Indian Reservation. The Uintah Mountains are covered with valuable forests of spruce, which protect the sources of several large streams which eventually discharge into Green River, those flowing northward from the range being already utilized for irrigation. The region within the borders of this proposed reserve is practically uninhabited, only 25 quarter sections of its land having been entered. There is, however, a large agricultural population already living in the territory immediately adjacent to it on the north and east, who find in the forests of the Uintah Mountains their only local timber supply, and this population will suffer for water if the fires which have now for many years swept through these forests are allowed to destroy them. If the Uintah Indian Reservation is ever purchased by the Government, all the northern mountainous portion, embracing the southern slopes of the western end of the Uintah Range, should be included in this forest reserve.

The total area of these thirteen proposed forest reserves, which are plotted on the accompanying maps, is 21,379,840 acres. The commission fully recognized the fact that the forest reserves established and proposed can not be maintained unless a plan can be adopted under which their boundaries can be modified so as to take from them all lands *better suited for* agriculture than for the production of forests, and

under which their timber can be made available for domestic and commercial purposes and valuable minerals can be freely sought for and mined within their boundaries. The commission is now engaged in perfecting a scheme of forest management which it believes will make the administration of the reserves possible, and which in due time will be submitted to you. It believes that the solution of this difficult problem will, however, be made easier if reserved areas are now increased, as the greater the number of people interested in drawing supplies from the reserved territory or in mining in them the greater will be the pressure on Congress to enact laws permitting their proper administration. For this reason it is the unanimous opinion of the commission that the establishment by proclamation of the reserves described above is now a matter of the utmost importance to the development and welfare of the whole country.

Very respectfully,

C. S. SARGENT,
Chairman.

ARNOLD ARBORETUM, HARVARD UNIVERSITY,
Jamaica Plain, Mass., April 6, 1897.

SIR: The legislation relating to reserved forest lands of the public domain which the commission of the National Academy will recommend in its final report now in course of preparation provides for the following:

First. That authority be given to the Secretary of War to make details of troops at the request of the Secretary of the Interior to protect temporarily and until a forest service is organized the property of the Government in the forest reservations from fire and trespass, and to enforce such rules and regulations as he may make for their care.

Second. The establishment of a permanent forest bureau in the Department of the Interior composed of trained officers to administer, maintain, and improve the reserved forest lands.

Third. The appointment of a commission to institute as rapidly as possible, under the supervision of the Director of the Geological Survey, topographical surveys of the reservations and determine what portions of them should be permanently reserved on account of their forest covering, and what portions should be reopened to entry and sale.

Fourth. To authorize the Secretary of the Interior to issue the necessary rules and regulations for the protection, growth, and improvement of the forests on the reservations; for the sale of timber, firewood, and fencing from them to actual settlers in and adjacent to the reservations, and to owners of mines legally located therein for use in such mines; for granting permits to sawmill owners to enter the reservations for the purpose of manufacturing such lumber as may be sold to actual settlers in and adjacent to the reservations and to the owners of mines located therein; for allowing actual settlers who have no ti

their own claims to take from the reservations firewood, posts, poles, and fencing material necessary for their immediate personal use; for allowing the public to enter and cross the reservations; for granting to county commissioners rights of way for wagon roads in and across the reservations; for granting rights of way for irrigating ditches, flumes, and pipes, and for reservoir sites; and for permitting prospectors, under such rules and regulations as he may from time to time establish, to enter the reservations in search of valuable minerals.

The commission will recommend that the reservations be opened to the location of mining claims under the general mineral laws, and that the owners of valid mining locations in the reservations made and held in good faith shall be permitted to fell and remove from their claims the timber growing on them for actual mining purposes in connection with the particular claim from which the timber is cut. It will also recommend that the owners of unperfected bona fide claims or patents of land included in the forest reservations shall be permitted to relinquish their claims to the Government, selecting in lieu tracts of vacant land open to settlement but not exceeding in area the tracts covered by their claims or patents; and that the owners of such unperfected claims shall not be subjected to additional charges for entries or record, and that credit shall be allowed them for the time spent on the relinquished claims. The commission will also recommend that the Secretary of the Interior be authorized to enter into negotiations with the land-grant railroad companies for the purpose of concluding agreements by which these companies may relinquish to the United States the title acquired by them to lands within their granted and indemnity limits when these lands lie within the boundaries of forest reservations, and may accept other unappropriated lands in exchange from the even-numbered sections within their granted and indemnity limits not included in forest reservations.

Very respectfully, your obedient servants,

C. S. SARGENT.
HENRY L. ABBOT.
W. H. BREWER.
ARNOLD HAGUE.
WOLCOTT GIBBS.
GIFFORD PINCHOT.

The SECRETARY OF THE INTERIOR,
Washington, D. C.

THE NATIONAL ACADEMY OF SCIENCES,
Washington, May 1, 1897.

SIR:—I have the honor to transmit to you herewith a copy of the complete report of the commission appointed by me on behalf of the

National Academy of Sciences, at the request of your predecessor, the Hon. Hoke Smith, to consider and report upon the inauguration of a rational forest policy for the forested lands of the United States.

I am, sir, very respectfully, your obedient servant,

WOLCOTT GIBBS,
President of the National Academy of Sciences.

Hon. CORNELIUS N. BLISS,
Secretary of the Interior.

REPORT OF THE COMMISSION APPOINTED BY THE NATIONAL ACADEMY OF SCIENCES UPON A FOREST POLICY FOR THE FORESTED LANDS OF THE UNITED STATES.

ARNOLD ARBORETUM, HARVARD UNIVERSITY,
Jamaica Plain, Mass., May 1, 1897.

SIR: The commission appointed by you, in compliance with the request contained in the following letter, has the honor to submit this report, which is based on actual examinations of much of the reserved and unreserved forest lands of the public domain and on a general study of the topography and climate, and of the economic conditions of the Western States and Territories:

DEPARTMENT OF THE INTERIOR.
Washington, February 15, 1896.

SIR: I have the honor, as the head of the Department charged with the administration of the public domain, to request an investigation and report of your honorable body, as is provided in the act incorporating the National Academy, and by article 5, section 5, of its constitution, upon the inauguration of a rational forest policy for the forested lands of the United States.

Being convinced of the necessity for a radical change in the existing policy with reference to the disposal and preservation of the forests upon the public domain, I particularly desire an official expression from your body upon the following points:

(1) Is it desirable and practicable to preserve from fire and to maintain permanently as forested lands those portions of the public domain now bearing wood growth, for the supply of timber?

(2) How far does the influence of forest upon climate, soil, and water conditions make desirable a policy of forest conservation in regions where the public domain is principally situated?

(3) What specific legislation should be enacted to remedy the evils now confessedly existing?

My predecessors in office for the last twenty years have vainly called attention to the inadequacy and confusion of existing laws relating to the public timber lands and consequent absence of an intelligent policy in their administration, resulting in such conditions as may, if not speedily stopped, prevent a proper development of a large portion of our country; and because the evil grows more and more as the years go by, I am impelled to emphasize the importance of the question by calling upon you for the opinion and advice of that body of scientists which is officially empowered to act in such cases as this.

I also beg to refer you to the proposed legislation which has been introduced into Congress for several years past at the instance of the American Forestry Association, supported by memorials of private citizens and scientific bodies, and more especially the memorials presented by the American Association for the Advancement of Science in 1873, which led to desirable legislation, and again in 1890, 1892, and 1894.

As I believe that a speedy change in the existing policy is urgent, I request that you will give an early consideration to this matter, and favor me with such statements and recommendations as may be laid before Congress for action during this session.

I have the honor to be, your obedient servant,

HOKE SMITH, *Secretary.*

Prof. WOLCOTT GIBBS,
President of National Academy of Sciences, Newport, R. I.

THE CONSERVATION OF FORESTS.

The influence of forests upon climate, soil, and the flow of water in streams has attracted much attention during the past century; but while the general consensus of opinion among experts is that this influence is potent and beneficial, the absence of exact data extending over long periods of time and the complex nature of the phenomena involved render it necessary to base this conclusion rather upon general considerations than upon statistics.

An elaborate statistical study of climatic changes has been undertaken in Europe by Gustav Wex, ministerial counselor and chief engineer of the Danube improvements at Vienna. His study is based on an analysis of all available water-gauge observations made on large European rivers during the last two centuries. Such records were collected for fifty-five stations on twelve rivers, all but two, the Tiber and Glommen, heading in central Europe.

These observations were discussed by dividing each record into two equal parts and finding for each half (about thirty years, more or less) the arithmetical mean of the mean annual stands and of the highest and lowest annual stages. Some of these records extend back more than a century; all are authentic, and relate to districts where the physical conditions and changes are well known. By comparing the mean levels (annual, flood, and lowest water) in the first half and last half of the periods covered by the observations, Wex believes that he can detect any secular variation in the flow of streams attributable to increased cultivation, and especially to the known destruction of forests. The following consolidated table derived from his two treatises[1] on the subject exhibits the general results of this analysis:

[1]Ueber die Wasserabnahme in den Quellen, Flüssen und Strömen bei gleichzeitiger Steigerung der Hochwässer in den Culturländern, Zweite Abhandlung über die Wasserabnahme in den Quellen, Flüssen und Strömen bei gleichzeitiger Steigerung der Hochwässer in den Culturländern, both translated by General Weitzel, of the Corps of Engineers, United States Army, and published in the Government *Printing* Office in 1880 and 1881.

River.	Records between—	Limiting periods.	Lower in second half period (inches per annum).			
			Stations.	Mean level.	Flood level.	Lowest level.
Rhine	Basle / Arnheim	1770–1874	22 in 23	0.11 to 1.44		
			27 to 28		0.07 to 2.91	
			26 in 28			0.10 to 1.44
Danube	Dillingen / Old Orsova	1822–1875	6 in 6	0.12 to 1.55	0.20 to 1.63	0.02 to 1.24
Elbe	Dresden / Magdeburg	1731–1873	7 in 7	0.39 to 1.28	0.11 to 1.95	0.36 to 1.14
Vistula	Cracow / Kurzeback	1809–1873	2 in 2	0.43 to 0.56	0.07 to 0.25	0.71 to 0.93
Oder	Custrin	1778–1835	1 in 1	0.36	0.32	0.34
Moselle	La Lobe / Sierk	1839–1866	2 in 2	0.47 to 0.82	0.62 to 0.93	0.31 to 0.81
Main	Busselheim / Kurtzburg	1845–1874	2 in 2	0.08 to 0.21	0.14 to 0.30	0.16 to 0.46
Theis	Szegedin	1851–1872	1 in 1	1.89		1.42
			0 in 1		a 0.95	
Po	Piecenza / Cremona	1837–1874	2 in 2	0.17 to 1.34		
			1 in 1		2.25	0.38
Tiber	Rome	1822–1871	1 in 1		1.31	0.53
			0 in 1	[1]0.45		
Seine	Paris	1800–1866	1 in 1	Not kept.	1.07	0.34
Glommen	Nastengen / Sarpfos	1847–1876	2 in 2	0.11 to 0.24		0.24 to 0.81
			0 in 2		[1]0.38 to 0.73	

a Rise.

In drawing conclusions from these data it should be remembered that the mean level for each year is derived from 365 observations, while the corresponding flood level and lowest water level are each determined by the records of only a few days, and are especially subject to exceptional variations. The mean levels are therefore entitled to the greater weight. Moreover, the highest and lowest points reached throw little or no light upon the durations of the corresponding high-water and low-water stages of the river, which are vital elements in estimating the discharge, and hence the general hydraulic conditions affecting the district.

The figures in the table indicate a pronounced lowering of the mean, of the flood, and of the low-water stages of these rivers, but that caution should be observed not to misinterpret the apparent flood change as implying a reduction of flood volume, or even of extreme flood height, is shown by the following quotations from Wex:

> The plots of the gauge readings show that in these rivers [the Rhine, Danube, Elbe, Vistula, and Oder] the floods in recent periods occur oftener and rise higher than in former times. It follows clearly, then, that during flood stages the discharge is much greater than formerly. These plots show, further, that the earlier floods were more regular than those of the later decades, in which excessive heights in one year are followed by very moderate heights in another, thus proving that very wet and very dry seasons occur more frequently and show greater variations than formerly. This is particularly noticeable for the Elbe and Vistula.

What conclusions are, then, to be drawn from these data in regard to the influence of forests upon climate and stream flow? They certainly demonstrate a progressive reduction in the mean annual, the flood, and the lowest water levels upon all the chief rivers draining central Europe, and that the change is very considerable. Wex claims that

this reduction is due to cultivation and to the extensive clearing of forested lands, and argues further that it implies a corresponding diminution in the annual discharge of the springs, streams, and rivers, and hence in the annual rainfall. This last inference has been disputed, because rain records kept during these same periods at Paris, St. Petersburg, and Copenhagen indicate no change. Wex replies that these cities are too near the coast and too far from the mountains to afford a check, and that rain records kept in the Erz Mountains and at Geneva do show small reductions.

Whether a grand climatic change in Europe be in progress or not, it would seem that the observed facts can be more simply explained by the well-established change in regimen often following the destruction of forests, especially in mountain regions. The more rapid melting of snow and the reduced obstructions to surface drainage hurry the water forward and increase the number and sometimes the extreme height of the spring freshets, leaving a less volume to be absorbed by the ground and gradually returned through springs and brooks during the low-water season. Destructive floods are thus rendered more frequent, and summer droughts more to be dreaded. But since both the mean velocity and the area of cross section, and hence for a double reason the discharge per second per foot of rise, increase much more rapidly in the higher than in the lower stages, such a change of regimen (the annual volume remaining unchanged) would exhibit itself by a reduced mean annual level, and a reduced low-water level.

The influence upon the flood level is less easily inferred, because in large rivers the extreme height attained depends more upon the coincidence of floods in the different tributaries than upon the height reached in each. If the change in regimen leads to less frequent coincidences than before, a much larger volume may pass off at a less flood height, lasting, of course, for a longer period.

Since these are the only data covering sufficiently long periods of time to be worthy of confidence, and since their indications can be logically explained without resorting to the hypothesis of a reduction in rainfall consequent upon cultivation and the destruction of forests, it can not be claimed that observation supports such an hypothesis. But the problem contains too many uncertain elements to warrant a purely theoretical solution, and it is therefore the part of wisdom to be cautious in advancing a claim that forests exert a beneficial influence upon the precipitation of moisture.

But however these valuable records be interpreted, whether they indicate a progressive change in climate or simply a change in river regimen, they certainly tend to confirm the belief generally entertained by experts, and based on facts observed at many widely different localities, that forests exert a most important regulating influence upon the flow of rivers, reducing floods and increasing the water supply in the

low stages. The importance of their conservation on the mountainous watersheds which collect the scanty supply for the arid regions of North America can hardly be overstated. With the natural regimen of the streams replaced by destructive floods in the spring, and by dry beds in the months when the irrigating flow is most needed, the irrigation of wide areas now proposed will be impossible, and regions now supporting prosperous communities will become depopulated.

Moreover, forests upon steep mountain slopes like those upon the public domain of the United States should be preserved to protect their surface. The soil on such slopes is held back by the roots of trees and shrubs and by grasses and other low plants, and protected against wind. When these are removed the soil washes down into the streams and is swept over arable lands in the valleys below, leaving the naked rock behind. In this way forest destruction on high mountain slopes produces results similar to those due to hydraulic mining in California, against which legislation by Congress has been sought and obtained. Millions of dollars have been expended during recent years in Europe in checking the force of floods due to denuded mountain slopes by the construction of stone dams and river beds and the planting of sod and trees; and in this country similar expenditures must follow the destruction of mountain forests if the narrow valleys of the West are to continue habitable.

In districts of less abrupt slopes the trees form and accumulate a mass of humus and absorbent materials which gathers moisture and holds the rain water until it can percolate into the subsoil through channels provided around their roots. Ultimately this ground water finds its way into springs and brooks, and promotes the general fertility of the region. Experience in every civilized country bears testimony to the fact that cutting away trees under such circumstances is followed by the drying up of streams and by less favorable conditions for local water supply.

But a well-regulated water supply is not the only thing dependent on the preservation of forests. In civilized nations the demand for lumber and other forest products is continuous, and requires systematic and intelligent forest reproduction. Numerous districts in our country have now no more timber than is needed for early use, and if forest reproduction is not encouraged local timber scarcity in the not distant future seems inevitable. The enormous waste from forest fires, incendiary and accidental, which prevail in nearly every part of the United States, the extravagant modes of lumbering, especially in the West, permitting valuable logs to rot in the brush on account of slight defects, and the universal neglect of all reproductive measures threaten the prosperity of the country and should receive early attention from the Government.

FOREST ADMINISTRATION IN FOREIGN COUNTRIES.

Before considering the American problem in detail, or any system for the administration of the public forests of the United States, it may be useful to briefly outline the forest measures which experience has dictated in other civilized countries, where, with the exception of Great Britain and China, the people enjoy the advantages of well-organized and efficient forest departments, which also exist in nearly all British colonies. Our political, social, and climatic conditions are so different, however, from those of the countries of the Old World that their methods of sylviculture and the legal complications resulting from their governmental, municipal, and private ownership of land possess little practical value for us at this time; but it is desirable that Congress should appreciate that forest administration is now regarded as an important government duty throughout the civilized world, and that it has been wholly neglected by the United States.

So many of the general features are common to all foreign forest systems that it will be necessary to consider only one of them in detail and to refer briefly to others which appear to afford good models for our consideration. That of France is selected for fullest explanation, not only because it dates from the Middle Ages, but because it is applicable to an entire country, without the confusing special conditions which in most European States are the result of local provincial subdivisions.

France.—Some kind of forest rules in connection with the game laws are said to have been handed down from the time of Charlemagne, but in 1669 Colbert, the minister of finance under Louis XIV, caused stringent forest laws to be enacted which proved of great benefit to the country. During the French Revolution the division of the large landed estates among many proprietors led to a general devastation of the forests, and induced legislation which finally, in 1827, established essentially the present forest administration system.

The central authority is vested in an administrative forest council, which consists of the minister of agriculture as president, the director of forests, and three officers entitled administrators. The forest council ordinarily meets once a week and deals with general matters pertaining to the forest administration.

The director of forests is the executive head of the forest service. His personal staff consists of two secretaries, one of whom is a forest inspector, and two clerks.

The three administrators are each the head of a bureau with headquarters in Paris, but they may be sent on special missions. In certain cases they act largely as inspectors, which was originally their exclusive duty. The first bureau deals with matters of law and police, purchases and condemnations of land, forest instruction, tools, supplies, etc. One of its sections is responsible for carrying into effect the

decisions of the forest council, and for office work connected with the inspecting tours of the administrators. The second bureau is charged with preparing working plans and the actual management of the forests. The third bureau deals with torrents, the reforesting of mountain slopes, the care of young plantations, and with dunes, roads, buildings, and pasturage.

The field personnel consists of 33 conservators, through whom all matters from below reach the central administration. Thirty conservancies are established in France, 1 in Corsica, and 3 in Algeria. In 11 of these conservancies officers of the working-plans division are stationed, and in 5 officers of the reforesting division.

In the lower grades are 232 inspectors, 249 assistant inspectors, and 274 "guards general," or a total of about 800 men in the superior forest service. Forest guards of all grades number 4,170, so that the grand total of the service is about 5,000 men.

The areas in charge of the forest service include the property of the Government, of communities, and of public institutions. In addition, a certain oversight, varying in closeness with situation and character, is exercised over the forest holdings of private individuals.

All members of the forest service below the grade of officer must have served in the army and, as a rule, must have attained the grade of noncommissioned officer. Their appointment and promotion are regulated by merit. They live in or near the forest, and each guard is charged with the care of about 2 square miles. Head guards superintend all work in progress and communicate the instructions of the officers. Police duties are an important part of their functions, including the right to make domiciliary visits and to arrest suspected persons. They take the oath of office and are prohibited from engaging in any industry connected with wood. They are entitled to pensions after completing twenty-five years' service, including the time spent in the army.

Forest products are sold by forest officers at auction or by the granting of permits, as the case may be, but the sums realized are paid directly into the public or communal treasury. Forest officers have nothing to do with the receipt or payment of funds.

Candidates for the grade of forest officer are, as a rule, trained at the National Forest School at Nancy, but one-third of the appointments are reserved for the promotion of deserving subordinates. After leaving the school the young officer is employed for about a year in learning his duties practically, under an inspector. His advancement and further promotion depend on his qualifications and exertions as reported by his immediate superiors. Forest officers are retired for age, as in the military service.

There are two forest schools in France—one for officers at Nancy, established in 1824, and another at Barres, to facilitate the promotion of deserving subordinates deficient in education. The course covers

two years, each comprising six and a half months of theoretical and two and a half months of practical instruction. The latter consists of tours into the forests near Nancy, the Vosges, the Jura, etc., for the purpose of studying foresty, natural history, and surveying, a part of the time being devoted to military exercises. Military science forms part of the theoretical course. Between the foundation of the school, in 1824, and 1887, 1,334 candidates for the forest service in France and 73 Englishmen had been received, the latter being admitted to prepare for service in India under a special arrangement made with the French Government.

Under the general law the forest department forms part of the army, which in the case of mobilization is at the disposal of the war minister. The officers hold rank in the reserve or territorial army, and in time of war may be employed in command of the forest corps or otherwise, as ordered. A military uniform is prescribed for all grades of the forest service, including the students at the schools.

The forest system of France has been extended to Algiers; but the governor-general has been invested with special powers, to avoid constant reference to the central Government.

The annual revenue from the Government forests of France and Algiers exceeds $6,000,000, and the expenses for 1896 were estimated at $3,300,000.

Germany.—The political division of the Empire causes the regulation of the forests to devolve largely upon the several states, and slightly different systems are adopted, according to local requirements; but the management in Prussia may be regarded as practically typical of the whole.

The destruction of forests which occurred in the seventeenth and eighteenth centuries has caused the advance of sand dunes from the shores of the Baltic, the washing away of surface soil in the western mountainous districts by torrential floods, and the overwhelming of fertile valleys with débris from mountain slopes. Forestry has thus been forced upon the attention of the Government. Bounties are granted to communes which undertake tree culture upon waste mountain slopes, seedlings and young trees are supplied at cost, and considerable sums are spent annually by the State in forest improvement, and especially in checking the advance of sand dunes.

Forest administration in Prussia is vested in the ministry of agriculture, domain, and forests. The minister regulates the maintenance and utilization of the State forests. His staff consists of a head State forester, a director, and four technical forest counselors.

Prussia is divided into 679 forest districts, each averaging about 9,000 acres in extent, and under the control af a head forester. The district is the unit of financial administration, all accounts passing from the head forester through an independent treasurer to the finance department of the Government for audit. The head forester is

charged with the entire management of his district. He receives a permanent appointment from the minister after passing a prescribed technical examination, and he is entitled to a pension. Under him serve foresters, forest guards, and assistant foresters, for whose performance of duties and pay he is responsible. In 1887 there were in Prussia 3,390 foresters and 349 forest guards. Previous service in the army is a condition of appointment to these grades, and the wearing of a uniform is compulsory, as indeed is the case with all grades of forest officials.

The next grade above that of head forester is that of forest master, who supervises several forest districts. Above him is the head forest master, who is a member of his provincial government and supervises all the forest districts within its limits. These officers are appointed by the Sovereign, upon the nomination of the minister of agriculture, domain, and forests, each being selected from the next lower grade, and in the case of head forest masters the provincial ministry being consulted.

There are two forest academies in Prussia, one at Eberswalde and the other at Münden. The course of study covers two years, and is designed to fit the pupil for the higher grades of the forest service. There are also two classes of preparatory forest schools, for practical instruction in the duties of the lower grades.

The forest administration of Prussia contributes a large sum to the revenue, the annual receipts being about $14,000,000 and the expenditures about $8,000,000.

British India.—The vastness of the forest area of British India, often arid, which has been successfully managed and protected, the varied climate and difficult sylvicultural conditions existing in these forests, and the great pecuniary success of the Indian administration, make it specially interesting to the students of the American problem, who find here many valuable suggestions.

The forest department code is applicable to all the provinces under the control of the government of India, but not the presidencies of Madras and Bombay, which, however, by special order may adopt the system.

The officers of the forest department are: One inspector-general, an assistant inspector-general, conservators of three grades of pay, deputy conservators of four grades of pay, assistant conservators of three grades of pay; also a director and instructor at the School of Forestry, and a superintendent of surveys.

The subordinate employees are graded as subassistant conservators, forest rangers, foresters, forest guards, etc.

The inspector-general is attached to the secretariat of the home department of the government of India. He assists in dealing with forest matters and controls the School of Forestry at Dehra Dun, the forest survey, and the working plans. He is aided by an assistant

inspector-general. He makes inspections and submits reports thereon either to the government of India or to the local governments; and he may correspond with the officers in local charge of forests but can not give orders to them.

Immediate forest management is vested in the local governments of the several provinces. Their executive is a conservator. His charge is divided into "divisions," "ranges," and "beats." The range is the unit of administration. It is subdivided into beats and grouped into divisions, each in immediate charge of a forest officer of suitable grade.

The numbers and pay of subassistant conservators are regulated by the government of India, which also fixes the maximum amount to be spent for the lower-grade employees. The appointments are made directly by the local governments or are delegated to the conservator. Subassistant conservators are usually promoted from the grade of forest ranger. Forest rangers are appointed from graduates of the Dehra Dun Forest School, or from subordinates of good record, or from native noncommissioned officers of the army.

Vacancies in the lowest grade of forest officer are filled (1) from candidates who have had a professional training in a manner prescribed or approved by the secretary of state for India, or (2) by promotion for special merit after a service of at least five years. Promotions in the lower grades are regulated by the local governments, but in the higher grades by the government of India. Seniority is recognized. Examinations and favorable reports from superiors influence the selections. Transfers from one province to another are exceptional below the grade of conservator. Officers are entitled to retirement, and may be reduced in rank for misconduct. All resignations must be accepted by the government of India.

Working plans are prepared by local officers, under the direction of local governments, but are subject to supervision and approval by the inspector-general. In case of disagreement reference is had to the government of India.

The Royal Indian Engineering College, at Cooper's Hill, England, since 1885 has had a forestry course, designed to fit students for the service in India. About ten graduate annually. Applicants selected by competition before the civil-service commission are then put to further tests by the Indian office, and, having taken the course at the college are, with application and good conduct, sure of appointment in the Indian forestry service.

The total area of forest land under the control of the forest service in 1894–95 was 12 per cent of the total surface of India, or 112,952 square miles, of which 74,271 miles were reserved forests, 7,090 protected forests, and 31,591 unclassed state forests. The increase for the previous year exceeded 9,000 square miles, acquired by the settlement or extinction of prescriptive rights. The total length of boundaries demarcated up to June 30, 1895, in Provinces under the government of *India alone, was* upward of 60,000 miles.

Working plans in operation cover 14,769 square miles, and in a territory of 30,963 square miles fires are kept in check. Protective measures failed on 6.6 per cent of this area during the last year, so that 28,913 square miles were effectively protected, at a cost of 8.75 rupees per mile. The present value of the rupee is about 30 cents, and therefore the cost of effective protection in India, where fires are at least as difficult to control as in the United States, is rather less than half a cent an acre per annum. An area of 33,420 square miles is covered by topographical surveys, executed in nearly the same proportion by the forest survey branch and the survey of India department. Forest offenses of all kinds during the last year averaged less than 1 to 3 square miles of forest.

The product of the great area administered by the forest service yielded during the year 1894–95 46,000,000 cubic feet of timber, 100,000,000 cubic feet of fuel, 134,000,000 bamboos, and minor products to the value of more than 3,000,000 rupees. The gross revenue from the forests is given at 16,788,880 rupees, and the net at 7,415,590, or about $3,000,000.

This surplus has grown from less than 2,000,000 rupees in 1870–71 to 2,500,000 rupees in 1880–81, to a little less than 7,000,000 rupees in 1890–91, and finally to almost 7,500,000 rupees in 1894–95, when the yield was nearly 1,000,000 rupees less than that of the year before. These results have been reached with a consistently conservative forest policy and in spite of the enormous drain made by the holders of prescriptive rights in the forests, which in 1894–95 amounted to nearly 6,000,000 rupees.

Systematic government forestry in India is of recent growth. The first Indian forest act was passed in 1865, although nearly ten years before Dr. Dietrich Brandis, the first inspector-general of the Indian forests, had begun to manage the teak forests of Pegu.

Dominion of Canada.—Physical and topographical conditions in Canada so much resemble our own that special interest attaches to its legislative measures regarding forests. As in the United States, the title to lands situated in the older Provinces and not held by individuals is vested in the provincial governments, while in the central and western Provinces the Dominion itself, as representative of the Crown, holds the fees. Hence result different and independent systems of forest administration in the different Provinces.

The Provinces of Ontario and Quebec, bordering upon the Great Lakes and the St. Lawrence River, and extending far to the northward, contain on the high table-lands that form the divide between the southern watershed and Hudson Bay immense areas of Crown lands which have never been sold, and which are generally rocky, unsuitable for the plow, and clothed with timber. In both of these Provinces the management of the Government forests devolves, under quite similar regulations, upon the department of Crown lands, the administrative direction forming a branch or bureau which is charged with public

instruction in forestry as well as with the supervision of the forested districts. The latter are divided into "agencies," of which the control is vested in officers denominated Crown lands and timber agents, having under them experienced woodmen called forest rangers, fire rangers, etc.

The agents are charged with the inspection and sale or lease of the public lands, the granting of licenses to cut timber, the collection of dues, and the protection of the public domain against trespassers and fires. Of the subordinates, some hold office during the entire year and others only during the dangerous fire months, the number of the latter being discretionary with the commissioner of Crown lands. The functions of justices of the peace, constables, and watchmen are performed by these subordinate officers. The last annual report for the Province of Quebec gives the names of such employees, amounting to 40 Crown lands and timber agents, 65 forest rangers, 73 fire rangers, 81 gamekeepers, together with a superintendent, an assistant, and 3 clerks of the branch of woods and forests, making a total of 264 officials. The total revenue from lumbering operations in this Province collected during the year ending June 30, 1896, amounted to $951,098.92.

The system of disposing of the timber on the Crown lands of Quebec and Ontario was adopted many years ago and has been found to work well, except that it does not provide for future crops of timber on lands unsuitable for tillage, and which therefore remain unsettled and unproductive after the forest has been removed. Under the rules now in force, when it becomes advisable to sell the timber from certain determined areas, forest rangers, who are experienced woodmen employed by the Government under the direction of the different Crown timber agents, are sent out to examine the forests and furnish the department of Crown lands with estimates of standing timber. The territory is then divided into timber "berths" of different sizes, which are advertised for sale at auction to the highest bidder, the department fixing a minimum price based upon the estimate of the forest rangers. The timber is sold at a rate per square mile subject to stumpage dues, but as these are low, large sums are bid by way of bonus for the license to cut over certain areas. At the last sale, that of 1892, the the sums paid in Ontario as bonus averaged $3,657.18 per square mile.

The timber when cut also pays dues on saw logs of from $1 to $1.25 per thousand feet, board measure, and on square dry timber of from $20 to $25 per thousand cubic feet. The timber licenses are for one year, renewable on the license holder complying with the conditions of the license, which include a yearly ground rent of $3 per square mile. Although the early licenses included all timber, in sales held since 1891 the white pine only has been specified. The land, it must be remembered, is not sold to the licensee or "limit holder," but is reserved for settlers. When the land under license is required for settlement, the licensee or limit holder is given a reasonable time to

remove the white pine, all other timber becoming the property of the settler on his complying with the terms of settlement. In case of unsettled land the limit holder, as long as he continues to pay ground rent, retains control of the limit until the land is required for settlement. Forest rangers under this system are also employed to watch areas not under license to prevent unlawful cutting of timber.

A provisional fire act, based on laws of several of our States, had, prior to 1886, been on the statute books of the Province of Ontario, but from lack of proper means for the enforcement of its provisions it had not succeeded in checking forest fires. In that year the system now in force was adopted and in practice has proved highly successful. Under its provisions a number of men are placed upon the Crown lands from May until October, when forest fires are most dangerous, in those localities specially exposed by reason of settlement, railway construction, or lumbering. Where the land is under license the cooperation of the limit holders is required, it being optional with them to avail themselves of the system. The number of men necessary to properly protect a piece of property is determined by the owners of the limit, who are supposed to be familiar with the country and with local conditions and special dangers. The selection of the men to be employed in this protective force is also left to the limit holders, the department reserving, however, the right to reject or remove any man whom it may consider unfit for the position.

These fire rangers are constituted officers for the enforcement of the fire act, and are governed by instructions from the department. They make the public acquainted with the provisions of the fire act by posting it in conspicuous places and circulating it among settlers and lumbermen. In case forest fires break out, they are authorized to engage assistants to suppress them; if dangerous, it is their duty to notify the limit holder and the department. One-half of the expense incurred in maintaining this forest staff and in suppressing fires is borne by the Crown lands department and the other by the owners of the limits. The pay of fire rangers is fixed at $2 a day, without board or other extras. The good effects of this system were especially manifested during the summer of 1895, which was extremely hot and dry. In consequence of this exceptional danger the staff of rangers was strengthened in specially exposed places and close vigilance was maintained.

Reports from 49 timber limits where this system was in operation during the summer of 1895 show that the value of the timber damaged by fire was only $41,600. The number of fires specifically reported was 93; in addition to these many others, principally small, were not enumerated in the reports of the fire wardens; and the Canadian forest officers are convinced that forest areas which might well have amounted to hundreds of square miles would have been burnt over during that exceptionally dry summer without the presence at exposed points of

this trained corps of Forest Rangers. This saving in Ontario has been effected by the employment of 114 men for a few months, at a total cost of $26,253, shared between the public treasury and the owners of timber limits. The Ontario forest-fire system has now been tried for nine years and its compulsory extension is recommended by the Canadian Government officers. In Quebec equally satisfactory results have followed the introduction of the forest-patrol system, which can no longer be regarded as experimental in that Province.

In the districts of Upper and Lower Ottawa during the summer of 1895, where it was also unusually dry, no serious conflagrations occurred. No less than fifty-six incipient fires, however, were extinguished by the Forest Rangers, any one of which might have assumed serious damages and caused heavy losses. The total damage in the district amounted to between $500 and $1,000. In other districts in Quebec numerous small fires are extinguished every year by Rangers, who, appearing promptly on the scene, assist the inhabitants in suppressing them.

The forests of the western provinces of the Dominion are under the control of the minister of the interior, who, following the system adopted in the older provinces, has under him Crown timber agents charged with the administration of suitable districts.

The value of the system which has been adopted in Canada, under which the Government retains the fee of its forest lands, would have been inestimable in large immediate revenue and in future crops of timber in such regions as those adjacent to Puget Sound or the coast of northern California; but the fee of nearly all the best timber land in the United States has now passed into the hands of individuals or corporations, and such a policy can now be applied only to comparatively small areas generally covered with inferior timber.

THE RESERVED FOREST LANDS OF THE PUBLIC DOMAIN.

The peculiar topographical and climatic conditions of western North America would appear to make the preservation of its forests essential to the profitable and permanent occupation of the country. The precipitation of moisture west of the one hundredth meridian is unequally distributed throughout the year; the summers are hot and dry, and the whole territory, with the exception of the coast region of the northwest, is watered so imperfectly that forests are restricted to the slopes of high mountain ranges or to elevated plains and mesas, the valleys of the interior and of all the south being practically treeless. In all the interior and southern regions precipitation is insufficient for certain and profitable cultivation, and permanent agricultural prosperity can only be assured through irrigation. Much of the region is traversed by lofty mountain ranges well wooded at the north and sparsely wooded at the south. Their forests serve to collect and in a measure regulate the flow of streams, the waters of which, carefully conserved and distributed *artificially, would* render possible the reclamation of vast areas of

so-called desert lands. Irrigation systems have been undertaken in many localities under State or corporate control and have been prosecuted until their value has been amply demonstrated, although the one essential condition of their permanent success, the preservation of the forests on high mountain slopes, has been entirely neglected.

Under authority of section 24 of the act of Congress approved March 3, 1891, by which the President of the United States can withdraw from sale and entry and set apart as forest reservations parts of the public domain, whether wholly or in part covered with timber, seventeen forest reserves, with a total estimated area of 17,500,000 acres, were established prior to 1894. During the journey made by your committee last summer through the Western States and Territories it became impressed with the importance of extending this reserved area before further encroachments were made on the public domain; and on its return it prepared a short preliminary report, recommending the establishment of thirteen additional forest reserves, with an estimated total area of 21,378,840 acres, and roughly designating their boundaries. On the 6th of February this report was submitted by the Secretary of the Interior to the President, who on the 22d of February issued proclamations making the recommendations of your committee effective. The correspondence relating to this matter is appended to this report. (Appendix A.)

Members of your committee visited during the summer and autumn all the forest reservations established prior to February 22, 1897, with the exception of the Pecos River Reserve in New Mexico, the Battlement Mesa Reserve in Colorado, the Yellowstone National Park Timber Reserve in Wyoming, already well known to its members, and the small and comparatively unimportant Afognak Reserve in Alaska, the Bull Run Forest Reserve in Oregon, and the Trabuco Canyon Reserve in southern California, and studied also forest conditions in many of the unreserved regions of the national domain. Beyond the limits of the national parks, which are effectively and economically patrolled by detachments of the United States Army, your committee was unable to discover any evidence that serious attempts are made by the Government to protect the forests of the public domain from illegal timber cutting and pasturing or to prevent the starting or check the spread of forest fires except in the north end of the Cascade Reserve, in Oregon, where in August it found a single agent of the Interior Department actively and successfully engaged in scattering several large flocks of sheep that had been devastating this reservation for several weeks.

Fire and pasturage chiefly threaten the reserved forest lands of the public domain. In comparison with these the damage which is inflicted on them by illegal timber cutting is insignificant. Timber can only be cut profitably when the operation is conducted on a comparatively large scale; and large operations require roads and sawmills, and consequently the use of capital, and are usually easy to detect and arrest.

The cutting of timber on the unreserved public lands under cover of bad laws or without a pretense of legal sanction causes, as we shall show later, serious losses to the Government, but, so far as we have been able to observe, it does not now seriously menace many of the reserves.

Forest fires.—Fires are particularly destructive to the forests of western North America. These are composed almost exclusively of highly resinous trees, which, when they grow beyond the influence of the moisture-laden air currents from the Pacific Ocean, ignite easily, and, burning fiercely on the surface, are quickly killed, while the flames sweep forward, leaving standing behind them the dead, although unconsumed, trunks to furnish material for later conflagrations and to intensify their heat. The climate, with its unequally distributed rainfall and intensely hot and dry summers and the peculiarly inflammable character of the forests, make forest fires in the West numerous and particularly destructive, and no other part of the country has suffered so seriously from this cause.

Fires in western forests are started by careless or ignorant hunters and campers, who often leave their camp fires burning or, in utter wantonness, ignite coniferous trees to enjoy the excitement of the conflagration. They can be occasionally traced to the effects of lightning, which locally is held responsible for many forest fires, although in reality fires set in this way are rare, as lightning is usually accompanied or followed by copious rains, which extinguish them before they can gain headway; and very rarely they are produced by the rubbing together of adjacent trees swayed by the wind. The right of way of every railroad crossing the Rocky Mountains and the other interior ranges of the continent is marked by broad zones of devastation due to fires which have started from the camps of construction gangs or the sparks of locomotives; and thousands of acres of timber are destroyed annually by the spread of fires lighted by settlers to clear their farms.

Prospectors in search of valuable minerals frequently set fires in wooded regions to uncover the rocks and facilitate their operations; and the shepherds who drive their flocks to pasture during the summer months in the mountain forests of Oregon and California make fires in the autumn to clear the ground and improve the growth of forage plants the following year. No statistics show the area of forests destroyed annually by fires in the Western States and Territories, but nearly every summer their smoke obscures for months the sight of the sun over hundreds of square miles, and last summer your committee, traveling for six weeks through northern Montana, Idaho, and Washington, and through western Washington and Oregon, were almost constantly enveloped in the smoke of forest fires.

Such conflagrations have occurred in the West since it was settled, and they will always menace the prosperity of that part of the country. Once fully under way, a fire in a forest of coniferous trees will spread

until it is extinguished by rain or encounters some natural barrier like a river, or, until driven back over its own course by a change of wind, it expires for want of material. No human agency can stop a Western forest fire when it has once obtained real headway, and the only hope of averting the enormous losses which the country suffers every year from this cause is in preventing fires from starting in the forests or in extinguishing them promptly. They will always occur, but the experience gained in the Yellowstone National Park since it has been patrolled by detachments of the United States Army and in Canada shows conclusively that with the aid of disciplined forest rangers intelligently directed the number of forest fires in any district can be greatly reduced and that it is frequently possible to extinguish small fires if they are energetically attacked when first discovered.

Nomadic sheep husbandry.—Nomadic sheep husbandry has already seriously damaged the mountain forests in those States and Territories where it has been largely practiced. In California and western Oregon great bands of sheep, often owned by foreigners, who are temporary residents of this country, are driven in spring into the high Sierras and Cascade ranges. Feeding as they travel from the valleys at the foot of the mountains to the upper alpine meadows, they carry desolation with them. Every blade of grass, the tender, growing shoots of shrubs, and seedling trees are eaten to the ground. The feet of these "hoofed locusts," crossing and recrossing the faces of steep slopes, tread out the plants sheep do not relish and, loosening the forest floor, produce conditions favorable to floods. Their destruction of the undergrowth of the forest and of the sod of alpine meadows hastens the melting of snow in spring and quickens evaporation.

The pasturage of sheep in mountain forests thus increases the floods of early summer, which carry away rapidly the water that under natural conditions would not reach the rivers until late in the season, when it is most needed for irrigation, and by destroying the seedling trees, on which the permanency of forests depends, prevents natural forest reproduction, and therefore ultimately destroys the forests themselves. In California and Oregon the injury to the public domain by illegal pasturage is usually increased by the methods of the shepherds, who now penetrate to the highest and most inaccessible slopes and alpine meadows wherever a blade of grass can grow, and before returning to the valleys in the autumn start fires to uncover the surface of the ground and stimulate the growth of herbage. Unrestricted pasturing of sheep in the Sierras and southern Cascade forests, by preventing their reproduction and increasing the number of fires, must inevitably so change the flow of streams heading in these mountains that they will become worthless for irrigation.

Other parts of the country have suffered almost as seriously from the nomadic sheep industry. Great flocks are wintered in the sheltered canyons of Snake River, and then, spreading through eastern Oregon,

A study of the forest reserves in their relations to the general development and welfare of the country shows that the segregations of these great bodies of reserved lands can not be withdrawn from all occupation and use and that they must be made to perform their part in the economy of the nation. According to a strict interpretation of the ruling of the Department of the Interior, no one has a right to enter a forest reserve, to cut a single tree from its forests, or to examine its rocks in search of valuable minerals. Forty million acres of land are thus theoretically shut out from all human occupation or enjoyment. Such a condition of things should not continue, for unless the reserved lands of the public domain are made to contribute to the welfare and prosperity of the country they should be thrown open to settlement and the whole system of reserved forests abandoned. Land more valuable for its mineral deposit or for the production of agricultural crops than for its timber should be taken from the reservations and sold to miners and farmers, the mature timber should be cut and sold, settlers within or adjacent to the boundaries, unable to procure it in other ways, should be authorized to take such material from reserved forests as is necessary for their needs, and prospectors should be allowed to search them for minerals.

But it must not be forgotten that the public domain of which these reserves form a part belongs to the people of the whole country, and not to those of any one section. It is right, therefore, that the forest reserves should be managed for the benefit of the people of the whole country, and not for any particular class or section. Steep and elevated mountain slopes should not be cleared of their forests for the sole benefit of the prospector or the miner, because this by its influence on water flow might mean permanent injury to persons living hundreds of miles away. A few foreign sheep owners should not be allowed to exterminate great forests at the expense of the whole country; and prospectors and miners should not be permitted to burn, willfully or carelessly, forests in which all classes of the community are equally interested.

Our examination of the Western forests shows that the existing methods and forces at the disposal of the Interior Department are entirely inadequate to protect the forests of the public domain. Civil employees, often selected for political reasons and retained in office by political favor, insufficiently paid and without security in their tenure of office, have proved unable to cope with the difficulties of forest protection, and the reserves are practically unguarded. Excluded from the provisions of the general land laws and without protection, they invite trespass of every kind and demoralize without benefiting the community. It is evident that if the Government proposes to protect public property in the reserves, and to enforce any laws or regulations which may be enacted for their administration, the assistance of the military must be called in until an organization can be developed in the Interior Department for the protection, management, and improvement

of all reserved Government forest lands; for without such assistance the experience of the past clearly shows that it is idle to hope that fires can be restricted, pasturage abolished, and timber cutting and mining regulated in the reserves; and if this can not be done their forests will sooner or later be ruined and the objects defeated for which they have been established.

PROPOSED SYSTEM OF FOREST ADMINISTRATION.

It has been shown that the preservation and judicious management of the forests on those portions of the public domain which are unsuited for agriculture are of great importance for the flow of rivers needed for the irrigation of arid districts, and to furnish forest products for settlers on adjacent arable lands, and for mining operations. The cheapness of forest products in the United States, and the length of time required to produce crops of timber in the West, will make the investment of the capital of individuals in silvicultural operations, for the present at least, a doubtful enterprise in those States and Territories where the public domain is now principally situated; and silviculture in western North America will only be really successful under sustained Government control and administration; for, dealing with crops which often do not reach maturity until the end of one or two centuries, it can only be made profitable by carrying out, without interruption and under thoroughly trained officers, plans which must often be followed during the lives of several generations of men. This stability and continuity of management can only be secured by a permanent Government administration composed of officers of the highest character, entirely devoted to duty.

Annual taxes on the land of individuals demand annual income; and to avoid or meet this burden of taxation land which should always remain covered with forests is often denuded before the requirements of commerce justify it, or is devoted to uses for which it is ill adapted. Private ownerships, for example, of the redwood-bearing land of the California coast region, the most productive forest land in the world, has resulted in this land, which should remain covered with forest for all time, being rapidly converted into indifferent pasturage. The fee of lands which are most valuable for the production of timber should remain vested in the General Government, and these lands, if they are managed wisely, can be made to supply forest material indefinitely to the agricultural and mining populations of adjacent districts and to improve in productiveness and value.

Ultimate self-support of a Government forest administration is possible in the United States, and it may be expected to yield a permanent income if the national forests are managed with the intelligence, thrift, and honesty which characterize the forest administration in Germany, France, and other European countries. At first, however, the cost of

administration will exceed the receipts, as is almost invariably the case in important economic reforms, but outlays may be expected to diminish in proportion as the administration is faithful, intelligent, and honest.

Temporary measures.—To inaugurate at once a complete system of forest administration would be to attempt more than is wise or feasible at this time; but the necessity of prompt action for the protection of the forest reserves from fire, illegal pasturage, and other depredations is urgent, and efficient temporary police measures are needed immediately. A plan for the temporary care of the forest reserves may be wisely based on the experience gained in the management of the national parks. This clearly shows that it is possible to protect forests in the most exposed and difficult parts of the public domain with small bodies of troops; whereas, before soldiers were detailed to police the Yellowstone National Park, all efforts to manage it by civil officers of the Government had shown the futility of any attempts at control which did not rest on the moral and physical support of the Army.

The collection and confinement of the Indians upon reservations, together with the rapid extension of settlements throughout the arid and semiarid regions of the West, have terminated the state of actual or quasi war which prevailed there less than a quarter of a century ago, and have freed the Army from the burden of active scouting which then consumed its time and energies. Under the new conditions, however, new duties have arisen, which make its presence hardly less important than it was under the old state of affairs. Not only is timber, the property of the nation and essential to supply the wants of farmers and miners, rapidly disappearing in consequence of forest fires, sheep grazing, and pilfering, but wide areas capable of supporting an industrious population are threatened with ruin from the destruction of mountain forests feeding the sources of streams necessary for irrigation. This danger is no less real than Indian massacre was formerly, and the citizens of the West can only look to the Army for immediate and temporary protection from it.

The patrolling and guard duty required will be professional in character, involving marches and practical experience in field service, which will be valuable as a preparation for war; and it is believed that it may be so combined with the usual field instruction now given to troops that it will accomplish not only the forest protection sought for, but also military training. The service will not be onerous, for many of the reserves will need no protection at present, and in others the danger period will not exceed two or three months annually. It is believed that this temporary detail of troops can readily be arranged between the Interior and War Departments in such a way that the objects desired can be accomplished without any detriment, and with many benefits, to the public service; and that the reserved forests can not be efficiently and cheaply guarded at this time in any other way.

Each important forest reserve should be placed at once in charge of *an officer of the* Army, detailed during the season when forest fires are

to be dreaded, to report to the Secretary of the Interior and to act as superintendent, and he should be supported by sufficient details of soldiers. In or near each forest reservation a United States commissioner should be stationed to deal promptly with all cases rising from violations of forest laws or regulations, and perform the duties of a police justice under a district attorney and the United States court. The authority to make arrests should be conferred upon the forest guards.

The primary object of such temporary management would not be to produce a revenue, but to protect the reserves against fire and depredation. It should be the duty of the superintendents to issue passes to persons desirous of entering or crossing them, and to keep a careful record of the names and residences of all such persons. Sheep should be wholly excluded from the reserves, and cattle should be admitted only in moderate numbers and when the property of actual settlers on adjacent lands.

Permanent forest organization.—The fundamental principle of any Government system of forest management should be the retention of the fee of forest lands, and the sale of forest products from them at reasonable prices, under regulations looking to the perpetual reproduction of the forest. While it is not desirable, perhaps, that the Government in the immediate future should enter into competition with the private owners of forest lands, it is evident that ultimately the sale of forest supplies from the Government timber lands should not only cover all expenses of Government forest management, but produce a steadily increasing income.

Upon officers charged with the administration of the Government forests will devolve the care of immensely valuable public property, its improvement under the best established scientific methods, police responsibility of exceptional delicacy, surveys, the construction of roads and engineering works for the protection of mountain slopes, and the control of numerous agents widely separated and not easily trained to habits of discipline. Many of these duties are essentially military in character, and should be regulated for the present on military principles. Wise forest management calls for technical knowledge which must be based on a liberal scientific education. The forest officers must be men of the highest personal character, who can be trusted to avoid participation in any private business connected however remotely with forest products. To secure the service of men qualified to meet these several requirements will call for liberal remuneration and permanent tenure of office.

The following permanent organization is recommended to meet these demands:

One director of forests, to have charge of a forest bureau in the Department of the Interior. He should be the president of an advisory board consisting of himself, an assistant director, and of four forest inspectors, and should have general charge of all matters relating to the forests on the public domain; he should approve all plans made by

his subordinates for the management of these forests. His staff should consist of a legal adviser well versed in the laws and regulations of the service, and of a disbursing officer to attend to the distribution of funds among the forest officers and to receive and audit their accounts. Such clerks as experience may show to be necessary should be provided.

An assistant director of forests, with authority to sign such letters, papers, and documents, and perform such other duties as may be designated by the director, to act as director in case of the absence of that officer or in case of a vacancy in the office of director. and to be a member of the advisory forest board.

Four inspectors of forests, each to have charge of a forest department and to be a member of the advisory forest board. The permanent stations of these officers should be at the most convenient localities in their departments, but they should assemble in Washington to confer with the director and with each other, and to discuss matters connected with the service. Each should have a legal adviser on his staff and as many clerks as necessary. All papers relating to his department, whether from superiors or inferiors, should pass through the office of the inspector.

The following limits are suggested for the four forest departments:

First department: To include the forest reserves comprised in California and Nevada. At present there are six such reserves, aggregating 6,867,200 acres.

Second department: To include the forest reserves comprised in Oregon and Washington west of the one hundred and twentieth meridian. At present there are six such reserves, aggregating 12,671,360 acres.

Third department: To include the forest reserves comprised in Arizona, New Mexico, Colorado, and Utah. At present there are eight such reserves, aggregating 6,141,440 acres.

Fourth department: To include the forest reserves comprised in Wyoming, South Dakota, Montana, and Idaho, and Washington east of the one hundred and twentieth meridian. At present there are eight such reserves, containing 9,117,440 acres.

Twenty-six head foresters, each to have charge of a forest district not too large for close personal supervision. The area of a district should vary according to locality, rarely comprising less than half a million acres or more than one and a half million acres. The district should form the unit of organization. Its chief should control his subordinates, regulate expenditures, prepare projects for and direct the execution of all public works, and should be responsible for the proper execution of all orders received from higher authority. Persons desiring to purchase forest products should apply to him; and if recommended by himself and approved by his forest inspector, he may make formal contracts, supervise the delivery according to the terms thereof, and duly notify the receiver at the nearest land office, or such other agent

of the Government as may be designated by competent authority to receive funds. In no case should payments be made to officers of the forest service. To the staff of each head forester should be attached a United States commissioner appointed by the judge of the United States court for that locality. This officer should hear all cases arising under violations of forest laws and regulations, and, where necessary, report them to the district attorney for prosecution in the United States court.

Twenty-six foresters to act as assistants, and in case of absence or illness of the head foresters to perform their duties. They should also disburse all Government funds and be responsible for all Government property in use under the forest organization of the district, but under the direction and subject to the approval of the head forester.

The fifty-eight officers designated should constitute a permanent forest corps, holding office for life during good behavior or efficiency, but subject to retirement at the age of 64 years; and their promotion should be by seniorty. They should be appointed by the President and confirmed by the Senate.

Under the temporary organization already suggested, officers of the Army will have had experience in forest administration, and some of the first appointments to the permanent forest corps would naturally be made from those officers who had shown special fitness for forest duty. The officers of the forest corps thus recruited from graduates of the Military Academy at West Point will have had the advantage of the military training required in the forest service and a scientific education well calculated to prepare them to profit by instruction in special forest schools in this country or in Europe. The certainty of future employment, dependent on ability and good behavior, will induce young men of good ability to seek employment in the forest service through this channel.

The disadvantage of being obliged to devote considerable time in the Academy to the study of subjects which have no immediate connection with forestry will be more than compensated for by the character of the education obtained there. There is now no other school in which the Government can train young men so cheaply and efficiently in many branches of knowledge which will be directly advantageous to them as forest officers. Provision, too, must be made for the admission into the forest corps of the graduates of other scientific schools and of universities in which special attention is given to scientific education. The graduates of West Point pass before graduation a severe Government examination. To make sure, however, of obtaining men equally well fitted for their duties from other schools and colleges these should pass a civil-service examination before they receive nominations by the President for appointment in the forest service, but no discrimination should be made against either. To provide at once technical forest education a certain number of graduates of the Mili-

tary Academy who may desire to enter the forest service should be sent for two or three years to one of the great forestry schools of Europe, and when these first officers have been graduated it should be their duty to organize at some convenient place near one of the great reservations a forest school for the instruction of the forest corps and of such civilians as may desire to avail themselves of its privileges.

Provision for the promotion of deserving individuals in the lower grades of the forest corps, to fill 50 per cent of the vacancies in that of officer, should also be made, not only as a reward of merit, but as an additional inducement for educated young men to enter this branch of the public service.

The following organization is recommended for the subordinate grades in the forest service:

Two hundred rangers, to serve under the orders of head foresters. The rangers should have authority to make arrests for violations of forest laws and regulations, and should thus be constituted a sort of national police. They should supervise all work undertaken on the reserves; should see that contracts for forest products are executed according to the terms agreed upon, and in general should act as assistants in the regulation of local affairs. Upon entering the service they should sign articles to serve for a period of five years, and they should be selected under civil-service rules by the head forester, under whom they are to act. Being eligible for promotion in the grades of forester under the conditions above indicated, it is believed that these positions will be sought by young men desirous of entering the service.

Assistant rangers, in such numbers as may be found necessary in the different districts after experience has made known the requirements of the service. They should be employed during the season when the reserves are frequently visited by campers and others and when fires are to be chiefly apprehended, and should be discharged when no longer needed. They should be appointed by head foresters under civil-service rules, and should have authority to make arrests for violations of forest laws and regulations. The routine manual labor of the reserves should devolve upon the assistant rangers.

The following are the rates of annual compensation suggested for forest officers, with an increase of 10 per cent for each period of five years' service: For the director, $4,500; for the assistant director, $4,000; for an inspector, $3,500; for a head forester, $2,500; for a forester, $2,000.

For the subordinate grades a monthly pay of $45 for rangers and of $35 for assistant rangers is proposed, with a gradual increase for length of service. Rations in kind, or a commutation, should also be furnished.

All officers of the service on reaching the age of 64 years should be entitled to receive 50 per cent of their pay at the time of retirement, and a like inducement to faithful service should be extended to rangers after a service of thirty years.

This organization will require for salaries, including those of rangers, for each of the first five years an annual appropriation of $250,000. While the number of officers proposed is much smaller in proportion to the area of the territory to be protected, now about 40,000,000 acres, than has been found necessary in other countries, it is believed to be sufficient for the immediate wants of the service. It is probable, however, that it will have to be enlarged in the future, when increase of population in the Western States and Territories and a greater demand for forest supplies than now exists will make the protection of the reserved forest lands more difficult and will justify more elaborate methods of forest management than now appear necessary, or when now unreserved forest lands of the public domain are controlled by the officers of the forest bureau.

When it is remembered that several million dollars' worth of timber are taken every year from the public domain without the Government being able to obtain any payment for it, it would appear a wise and economical policy to spend annually a few hundred thousand dollars on an organization which would prevent such unnecessary drains on the wealth of the nation. It must be remembered also that an efficient forest administration would be able to prevent many forest fires on the public domain, and that it is not an unusual occurrence for a single fire to destroy material in a few days worth more in actual money than this forest administration would cost in years, while the loss to the country in impaired water flow through forest fires, which might be easily prevented, is incalculable. The expenditure, therefore, of $250,000 a year in furnishing means for protecting the forests on the public domain would appear to be justified by every consideration of common sense and economy.

The example, moreover, of wisely directed national forests may be expected to be a substantial benefit to the private interests of the citizens of the United States, both as object lessons and in the opportunity they would offer for the special training of foresters. Such examples would gradually change the wasteful methods now practiced by individual owners of forest property, and in this way increase national wealth and prosperity. Your committee fully realizes that the organization of such an administrative bureau of civil officers would be a radical departure from the recognized customs of the United States. The nature and extent of the interests at stake, however, and the difficulty, delicacy, and permanency of the duties demand an exceptionally stable service. The experience of all other countries shows that this service can be successfully performed only by highly trained and conscientious officers.

Board of forest lands.—Topographical and economic surveys upon which it would have been possible to establish scientifically the proper boundaries of the reserved lands do not exist, and their limits have been laid down roughly, with the idea that they would be modified as

soon as it was possible to determine accurately what portions were more valuable for the production of minerals and for agriculture and grazing than for their timber growth and that such lands would then be opened to entry and settlement. In all the forest reserves visited by your committee it saw opportunities to improve their boundaries, and found lands which can not be permanently reserved without inflicting serious hardships and losses on the community. Only a small portion of the White River Plateau Timber Land Reserve in Colorado, for example, is forest land, the remainder being covered with grasses and scattered clumps of oak bushes. Such land is, of course, most valuable for pasturage, and its withdrawal from use cripples the important cattle industry of the region. In the Washington Forest Reserve and in the Cascade Forest Reserve are mineral deposits which can not wisely be held from entry, and near the borders of others there are lands more valuable for agriculture or fruit growing than for other purposes.

It is evident that such lands should be taken from the forest reserves as soon as it is practicable to do so; but before this can be done safely those parts of the public domain which have been reserved, or which may be reserved, should be accurately surveyed and carefully mapped. As the United States Geological Survey is the only bureau in the Department of the Interior equipped for this work it can probably most conveniently make these surveys. Their proper interpretation is a matter of the greatest importance, for on the men who undertake it will devolve the duty of establishing the final boundaries of the reserved forest lands of the public domain. Enormous interests are involved in these final decisions, and this work can be intrusted only to men of the highest integrity, intelligence, and public spirit. Efforts will certainly be made to improperly influence their judgment, and they will be subjected to severe temptations. The power to open any part of the reserved lands to settlement is in the hands of the President of the United States, but he will necessarily base his decisions in such matters on the reports and recommendations of the experts who are to study the results of the surveys made under the direction of the Geological Survey.

To provide for this important duty, we recommend that the President be authorized to appoint a commission, to be known as the board of forest lands, to consist of an officer of the Engineer Corps of the Army, a member of the Geological Survey, a member of the Coast Survey, and two persons not connected with the public service, and that it shall be the duty of this board to determine, with the aid of actual surveys and such other examinations as may be found necessary, the boundaries of those parts of the public domain which should be retained permanently by the Government as forests, and that upon its recommendations the President should be authorized to open all other lands to entry and sale. It is believed that the character of this commission can be best

maintained at the highest level by limiting the remuneration of the two members unconnected with Government service to their actual expenses.

In all the forest reserves individuals have acquired more or less perfect title to land, and as they may claim that their rights are interfered with, or the value of their holdings diminished, by the reservation from entry of adjacent lands, opportunity should be given them to exchange on an equitable basis their lands or rights for those of similar character outside the reservations. Several of the forest reserves are within the limits of land grants made to railroad corporations, and it should be possible for the Secretary of the Interior to arrange with these corporations to exchange their holdings within the reservations for similar unreserved lands.

THE UNRESERVED FOREST LANDS OF THE PUBLIC DOMAIN.

The laws now in force under which the timber and timber lands of the public domain are disposed of have proved inadequate and demoralizing in practice; and the repeal or amendment of every one of them has been urged year after year by successive Commissioners of the General Land Office and Secretaries of the Interior, and it is not an exaggeration to say that, inviting fraud and peculation, they have debased the public conscience and deprived the Government of millions of dollars.

The act of June 3, 1878 (20 Stat., 88), known generally as the act to allow the cutting of timber on mineral lands, permits citizens of the United States and other persons, bona fide residents of Colorado, Utah, Nevada, New Mexico, Arizona, Wyoming, North and South Dakota, Idaho, and Montana, and all other mineral districts of the United States, to cut and remove for building, agricultural, mining, and other domestic purposes any trees growing on mineral lands, subject to such rules and regulations as the Secretary of the Interior may prescribe for the protection of the timber and undergrowth on such lands. This act, which was loosely and unskillfully drawn and abounds in indefinite phrases, has been subject to such varying and conflicting decisions, both official and judicial, as to the true construction to be placed on the expression "mineral lands" that it practically gives away all the timber in regions in which any mineral lands are situated, and has been fitly described as the greatest gift ever made by Congress.

It has been construed to authorize the free and unlimited cutting of timber on any reputed mineral lands without supervision or restraint, beyond the ruling of the Secretary of the Interior that no trees less than 8 inches in diameter can be felled and that no timber taken under its provisions can be exported out of the State or Territory where it is cut. Allowing settlers and miners to provide economically for their actual wants, it has without doubt stimulated a wasteful consumption of

timber beyond actual needs and has led to wanton destruction. Little attention has been paid to the regulations of the Secretary, and all land in mineral districts has been held by owners of sawmills, mines, and traffic lines, without survey or examination, to be mineral land and therefore subject to it provisions. Under this act companies employing large forces of men have been formed to cut and remove the timber from so-called mineral lands and ship it to their mills; lumber dealers, mill owners, and railroad contractors have cut timber under its provisions for commercial purposes, and lumber cut on lands held to be mineral by the men who plunder the public domain under the protection of this act has been sent by rail to cities in distant States.

Individual avarice and corporate greed have vied in accepting this bounty offered to them by the Government, and the most valuable timber accessible to railroads has already been cut from all reputed mineral lands. A conspicuous and notorious example of what this act has accomplished is seen in South Dakota, where the forested lands among the Black Hills, although only a small part of them have been surveyed, have been held by the mining companies of the region to be mineral lands; and for years these companies, under the provisions of this act, have consumed large quantities of timber and firewood without being subjected to any charge. In this region, which affords a fair example of what is going on in other mineral regions, no attention has been paid to the regulations of the Secretary of the Interior, under which timber less than 8 inches in diameter can not be cut; and there is now pending a suit in the United States court by the United States against the Homestake Mining Company for timber cut before 1891 under 8 inches in diameter, amounting to about $688,000. Special agents of the General Land Office several years ago estimated that the value of the timber cut at that time by this company amounted to between $2,000,000 and $3,000,000, but owing to ignorance as to the nature of the land and uncertainties of the law no suit has been brought to recover the value of any part of it cut from trees above 8 inches in diameter.

This company has built and operates a railroad nearly 40 miles long into the public domain for the purpose of bringing timber and fuel to its mines from land which has not yet been shown to be mineral, and is destroying the forest as far back from this line of railroad as timber can be easily and profitably moved. It is a matter of common report that millions of feet of lumber cut on the public domain in the Black Hills under the authority of this act have also been shipped by rail and sold in Omaha, although the Government has received no compensation whatever from the companies carrying on these operations. To this act can also be traced the destruction of immense forests in Colorado, Nevada, Arizona, and Montana, and whenever it can be made applicable the evil results which have followed its passage are plainly visible.

The act of March 3, 1891 (26 Stat., 1093), permits residents in the States of Colorado, Montana, Idaho, North Dakota, South Dakota, *Wyoming,* Nevada, Alaska, and Utah to take timber from nonmineral

public lands therein under rules and regulations prescribed by the Secretary of the Interior, and the act of February 13, 1893 (27 Stat., 444), extends the provisions of this act to Arizona and New Mexico. Under the provisions of these acts the Secretary of the Interior is authorized to issue permits to cut timber on unreserved nonmineral lands, but it provides for no compensation for the Government in return for these privileges. The intention of the act was doubtless to enable actual settlers to obtain legally from nonmineral lands necessary forest supplies for their own immediate use. In reality it has been taken advantage of by rich and powerful corporations, who, securing permits without difficulty to cut timber for commercial purposes, prevent as far as possible agricultural settlers and the owners of mining claims from obtaining them, and, in this way preventing competition, control the market for the timber which the Government presents to them.

The largest and wealthiest mining corporation in Montana is now supplied with timber cut principally under the provisions of this act, and lumber manufactured from trees cut under its authority is sent by it to many parts of that State. The bounds of the lands on which authority to cut timber under this act is given are never clearly marked, and there are reasons for believing that little attention is paid to them in actual practice. The act and its working has favored wealthy corporations able to pay the Government for all the timber they require. It is unjust in its discrimination against the residents of those States and Territories which are not included in its provisions and in its gifts to the competitors of individuals and firms who have acquired timber by the purchase of lands under the timber and stone act of June 3, 1878, or otherwise.

The act of June 3, 1878 (20 Stats., 89), known generally as the timber and stone act, authorizes the sale of unreserved surveyed but unoccupied timber lands in California, Nevada, Oregon, and Washington in quantities not exceeding 160 acres to one person or association of persons at $2.50 an acre, and by the act of August 4, 1892 (27 Stats., 348), the provisions of this act are extended to embrace all the public-land States. Under the workings of these acts great bodies of valuable timber lands speedily passed into the hands of individuals and of corporations and syndicates, domestic and foreign, for purposes of speculation, the Government obtaining only a small percentage of the actual value of the standing timber. It has been made use of by corporations and wealthy individuals to secure fraudulently, for the purpose of manufacturing lumber, or to hold for speculative purposes, most of the valuable redwood lands of the California coast region and great bodies of the sequoia and sugar pine forests of the Sierra Nevada, and much of the best timber land on Puget Sound has also been taken from the national domain under authority of this act.

Some of the most valuable timber land in the world has thus been acquired at mere nominal prices through the medium of dummy entries, for it is a notorious fact that the greater part of the entries under this

act have been made in the names of poor and ignorant people who have never seen the lands and who, immediately after the issuance of the final certificates, have transferred their claims to corporations or individuals dealing in lumber or timber lands; and it has been shown that at one time in California regular agents employed by lumbermen were authorized to offer men $50 apiece to make entries of land covered with redwood timber and deed them to their employers. Similar frauds have been practiced in Oregon and Washington, and in other States, since the extension of the law. This act has robbed the Government of the United States of its most valuable timber land, worth at market prices many millions of dollars, for which it has received no adequate return, and has demoralized and degraded whole communities.

By the act of March 3, 1875 (18 Stats., 482), right of way through the public lands of the United States is granted to any railroad company which had filed with the Secretary of the Interior due proof of its organization, etc., and also the right to take, from lands adjacent to the line of the road, timber necessary for its construction. Such loose and ambiguous terms as "adjacent lands" and "construction purposes" used in this act have served as a cover for illegal speculation in public timber and have fostered its unlicensed waste and destruction.

Under the provisions of this act large quantities of timber from the public domain have been cut and removed for export and sale. Corporations have been formed in which the railroads were the principal owners for monopolizing the timber traffic in the northern Rocky Mountains, and these corporations have cut timber from unsurveyed public lands far from the right of way of any railroad and have shipped the product to distant markets. Millions of feet of public timber have been unlawfully appropriated under this act, the elastic term "adjacent to the line of railroad" having been held to extend to any distance where timber could be found, and the term "construction purposes" to apply not only to the roadbed, but to station houses, depots, snowsheds, and even to rolling stock.

The attempts made by the Department of the Interior and the courts to properly construe the terms "adjacent" and "construction" have resulted in conflicting rulings, and the question is still undecided whether "adjacent" timber lands means 1 or 100 miles from the road, whether it lies laterally from the line of the road or from its terminus, or whether it means land conveniently accessible by railways or waterways, while the term "construction" is held by some authorities to apply only to the roadbed proper and the first laying of the tracks, and by others to extend also to subsequent changes of gauge and to the construction of bridges, snowsheds, stations, and freight houses. The timber taken from the public domain for railroad purposes under the provisions of this act has resulted in an enormous waste and the unnecessary devastation of forests along water courses and the head waters of streams which should have been preserved for the general good of *the public.* While it may have been necessary when the first trans-

continental railroads were built to permit them to take timber from the public domain for actual purposes of construction, there is no longer any reason why privileges of this sort should be granted to corporations in one part of the country and not in others, or why any corporation which may desire in the future to build new railroads or extend existing lines in the public-land States should not buy and pay for the timber it may require for construction.

The act of June 8, 1872 (17 Stat. L., 339), allows the Denver and Rio Grande Railroad Company to take timber without supervision or control from the public domain for the repairs of its line. This is an unjust discrimination in favor of this particular road, granting it privileges which are not enjoyed by any other railroad in the United States and permitting it a continuous use of public timber practically for all time. It is clearly unjust that this valuable privilege should be granted to one particular road while corporations controlling competing lines of railroad are obliged to pay for the timber needed to keep their roads in repair; and this act is peculiarly dangerous because the country tributary to the Denver and Rio Grande Railroad was never well timbered and has suffered more than most other parts of the United States from forest fires and injudicious cutting.

The United States has proved its inability to enforce the rules and regulations established from time to time by the Secretary of the Interior to protect its interests in its own timber lands; and attempts made to recover the value of timber unlawfully cut from the public domain have failed through the ambiguity and defectiveness of the various acts under which it was hoped that actual settlers might secure forest supplies, and because the sentiment of a majority of the people in the public-land States with regard to the public domain, which they consider the exclusive property of the people of those States and Territories, does not sustain the Government in its efforts to protect its own property, juries, when rare indictments can be obtained, almost invariably failing to convict depredators. This is shown by the following table, compiled from the records in the General Land Office, and covering the last eleven years:

Year.	Timber and lumber illegally taken from the public domain.	Amounts sued for.	Amounts recovered by suits.	Amounts recovered by compromise.
	Feet B. M.			
1886	1,245,250,000	$5,774,272.84	$77,933.35	$23,152.96
1887	1,029,100,000	2,082,236.72	112,952.87	15,689.22
1888	861,800,173	3,795,620.99	102,823.92	25,698.72
1889	3,359,525,410	12,113,326.26	161,347.80	20,538.41
1890	2,109,392,000	359,583.63	83,420.50	17,244.82
1891	1,425,876,209	954,874.20	62,402.47	53,863.03
1892	195,751,300	440,463.41	35,010.93	49,539.48
1893	47,708,000	27,290.63	43,049.42	11,503.24
1894	760,160,400	15,322.47	21,290.56	2,230.87
1895	158,801,965	344,683.44	31,081.36	16,698.70
1896	227,241,775	325,471.23	140,452.73	42,247.18
Total	11,420,607,202	26,233,145.82	871,765.91	278,406.63

In this table amounts sued for and amounts recovered do not represent the trespass cases reported in the same year, the damages being recovered from cases previously reported. The amounts sued for represent only the values of timber in those cases in which sufficient evidence was found upon which legal proceedings could be based with any hope of success. Many cases are investigated and reported to the General Land Office in which undoubtedly trespasses have been committed, although it is found difficult to secure sufficient evidence to justify the institution of suits.

The amounts sued for in the above table represent the market values of the timber in the condition and position where it was found. The following table shows the stumpage value of timber trespass reported by special agents to the General Land Office during the fiscal years 1886 to 1896, inclusive:

1886	$1,726,516.89	1893	$44,383.71
1887	965,576.04	1894	360,893.78
1888	840,145.15	1895	169,317.32
1889	1,182,987.14	1896	140,210.28
1890	832,420.48		
1891	349,440.62	Total	6,836,900.51
1892	225,009.10		

Or an average yearly value of $621,536.41.

It has long been apparent to all disinterested persons familiar with the working of the land laws of the United States that the acts which we have described should be repealed, and unless this is done it is evidently only a matter of a comparatively short time when all the valuable timber will have been destroyed on the unreserved public lands or will have passed into the hands of individuals. Unless, therefore, the Government is prepared to abandon control of the water supply of many streams needed for irrigation and to see the whole of its unreserved territory west of the one hundredth meridian stripped of its valuable timber and agricultural and mining interests crippled, it must contemplate the adoption of some policy like that which, after a fair trial, has proved successful and profitable in Canada, and under which all public lands in the Western States and Territories more valuable for their forests than for agriculture or the production of minerals can be reserved to protect the flow of rivers and to produce timber to supply the needs of agriculture and mining and the demands of commerce.

This can be accomplished by withdrawing now from sale and entry all public lands more valuable as timber lands than for other purposes through the repeal of the various acts under which timber and timber lands can be acquired by individuals and corporations. Such reserved lands should then be surveyed as rapidly as possible, in order that their true character can be accurately defined, and such parts of them as may be found less valuable as forest lands than for other purposes opened to sale and entry, while the remainder should be held permanently by the General Government and administered by a competent forest bureau for the benefit of the people in the whole country. A

scheme for the withdrawal of the forest lands of the public domain from sale, for their survey, and for their administration in such a manner that actual settlers, prospectors, and the owners of mining claims may obtain free and abundant supplies of timber for their actual needs, and that commerce may be supplied with forest products, will be found in the draft of the bill marked No. 3 attached to this report. Its passage, if these forest lands are wisely administered, will insure the permanency of many waterways in the arid States and Territories; it will enable agricultural settlers and the owners of mining claims to obtain under protection of the law such forest supplies as they may actually need for their personal use; and it will compel great corporations controlling mines, traffic lines, and sawmills to buy from the Government at public auction, in such quantities as they may require, the timber which they now take under one pretext or another and generally without payment.

ADDITIONAL NATIONAL PARKS.

Parts of two forest reserves contain features of supreme natural beauty, and can best be preserved for the enjoyment and instruction of the world by creating them national parks and governing them under the rules and regulations which have proved successful in protecting the Yellowstone National Park. The first of these is the upper slopes of Mount Ranier, in Washington, with its glaciers, its alpine meadows clothed with flowers, and the fringe of forest which maintains a precarious foothold on the steep ridges below the line of its perpetual snows. This mountain is one of the highest and most beautiful in North America, and outside of Alaska its glaciers are unrivaled in magnitude and interest in the United States. Memorials have been presented to Congress by the American Association for the Advancement of Science, the Geological Society of America, the Sierra Club, and the Apalachian Mountain Club favoring the establishment of this national park, and an act setting aside certain lands for it was passed by the Fifty-fourth Congress at its second session; but the bill, by extending to it the mineral-land laws, might have destroyed its scenic value, and it did not receive Executive sanction.

The second spot which we believe should be made into a national park is that portion of the Grand Canyon Reserve in Arizona which is immediately adjacent to and includes the walls of the canyon itself. These two localities, Mount Ranier in Washington and the Grand Canyon of the Colorado in Arizona, are each in its particular way unsurpassed in interest. Their natural wonders should be preserved without further defacement than is necessary to make them easily accessible to the people; and unless mining is prohibited in their immediate neighborhood, and unless they can be strictly guarded against fires, their scenic value will be seriously impaired. As this protection can only be secured by the adoption of the rules and regulations similar to those which govern the national parks, we recommend the establishment of a Ranier national park and a Grand Canyon national park.

CONCLUSIONS AND RECOMMENDATIONS.

The Secretary of the Interior, in his letter of February 15, 1896, asked the Academy whether "it is desirable and practicable to preserve from fire and to maintain permanently as forest lands those portions of the public domain now bearing wood growth for the supply of timber."

Your committee is of the opinion that it is not only desirable but essential to national welfare to protect the forested lands of the public domain, for their influence on the flow of streams and to supply timber and other forest products; and that it is practicable to reduce the number and restrict the ravages of forest fires in the Western States and Territories, provided details from the Army of the United States are used for this purpose permanently, or until a body of trained forest guards or rangers can be organized. It does not believe that it is practicable or possible to protect the forests on the public domain from fire and pillage with the present methods and machinery of the Government.

In answer to the second question submitted by the Secretary of the Interior, "How far does the influence of forests upon climate, soil, and water conditions make desirable a policy of forest conservation in regions where the public domain is principally situated?" It is the opinion of your committee that, while forests probably do not increase the precipitation of moisture in any broad and general way, they are necessary to prevent destructive spring floods, and corresponding periods of low water in summer and autumn when the agriculture of a large part of Western North America is dependent upon irrigation.

The answer to the third question, "What specific legislation should be enacted to remedy the evils now confessedly existing?" will be found in the series of proposed bills appended to this report. They present the following recommendations:

(1) That the Secretary of War, upon the request of the Secretary of the Interior, shall be authorized and directed to make the necessary details of troops to protect the forests, timber, and undergrowth on the public reservations, and in the national parks not otherwise protected under existing laws, until a permanent forest bureau in the Department of the Interior has been authorized and thoroughly organized. (See bill No. 1.)

(2) That the Secretary of the Interior shall be authorized and directed to issue the necessary rules and regulations for the protection, growth, and improvement of the forests on the forest reserves of the United States; for the sale from them of timber, firewood, and fencing to actual settlers on and adjacent to such reserves, and to the owners of mines legally located in them for use in such mines; for allowing actual settlers who have no timber on their own claims to take from the reserves firewood, posts, poles, and fencing material necessary for their immediate personal use; for allowing the public to enter and cross the reserves; for granting to county commissioners rights of way for wagon

roads in and across the reserves; for granting rights of way for irrigating ditches, flumes, and pipes, and for reservoir sites; and for permitting prospectors to enter the reserves in search of valuable minerals; for opening the reserves to the location of mining claims under the general mineral laws; and for allowing the owners of unperfected claims or patents, and the land-grant railroads with lands located in the reserves, to exchange them under equitable conditions for unreserved lands. (See bill No. 2, secs. 2–4.)

(3) That a bureau of public forests shall be established in the Department of the Interior, composed of officers specially selected with reference to their character and attainments, holding office during efficiency and good behavior and liberally paid and pensioned. (See bill No. 2, secs. 5–11.)

(4) That a board of forest lands shall be appointed by the President to determine from actual topographical surveys to be made by the Director of the Geological Survey what portions of the public domain should be reserved permanently as forest lands and what portions, being more valuable for agriculture or mining, should be open to sale and settlement. (See bill No. 2, sec. 15, and bill No. 3, sec. 6.)

(5) That all public lands of the United States more valuable for the production of timber than for agriculture or mining shall be withdrawn from sale, settlement, and other disposition and held for the growth and sale of timber. (See bill No. 3.)

(6) That certain portions of the Rainier Forest Reserve in Washington and of the Grand Canyon Forest Reserve in Arizona shall be set aside and governed as national parks. (See bills Nos. 4 and 5.)

Yours, respectfully,

CHARLES S. SARGENT.
HENRY L. ABBOT.
A. AGASSIZ.
WM. H. BREWER.
ARNOLD HAGUE.
GIFFORD PINCHOT.
WOLCOTT GIBBS.

To the PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

APPENDIX A.

No. 1.

A BILL for the temporary protection of the public forest reserves and national parks of the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That until a bureau of forests in the Department of the Interior has been authorized by Congress and duly organized for the protection of the public forest reserves, the Secretary of War, upon the request of the Secretary of the Interior, is hereby authorized and directed to make the necessary details of troops to protect the forests, timber and undergrowth, and natural curiosities in the public forest reserves and the national parks not otherwise protected under existing law, and to enforce the rules and regulations prescribed by the Secretary of the Interior for the protection of such reserves and parks, which he is hereby authorized to make and promulgate and which shall have the force and effect of law.

SEC. 2. That it shall be the duty of the troops detailed for service under the provisions of this act, and of any officer or employee of the United States, to arrest any person found violating any of the rules and regulations prescribed by the Secretary of the Interior hereunder, and take such person before the nearest United States commissioner, within whose jurisdiction the reserve or park is located, for trial. And upon sworn information by any competent person, any United States commissioner, in the proper jurisdiction, shall issue process for the arrest of any person charged with the violation of the rules and regulations made under the provisions of this act. But nothing herein contained shall be construed as preventing the arrest by any officer of the Government, without process, of any person taken in the act of violating any regulation of the Secretary of the Interior made in pursuance of this act.

SEC. 3. That it shall also be the duty of the troops detailed for service under the provisions of this act to prevent, as far as possible, the lighting and spread of forest fires in said reserves and parks.

No. 2.

A BILL to protect and administer public forest reserves.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the objects for which public forest reserves shall be established under the provisions of the act approved March third, eighteen hundred and ninety-one, shall be to protect and improve the forests for the purpose of securing a permanent supply of timber for the people and insuring conditions favorable to continuous water flow. And all such forest reserves shall be controlled and administered in accordance with the provisions of this act and the rules and regulations prescribed hereunder; and all acts and parts of acts inconsistent with the provisions of this act and the rules and regulations prescribed hereunder are hereby repealed.

SEC. 2. That the Secretary of the Interior is hereby authorized and directed to issue all necessary rules and regulations for the protection, growth, and improvement of the forests on the forest reserves of the United States; for the sale therefrom of timber, firewood, and fencing to actual settlers on and adjacent to such reserves, and to owners of mines legally located therein for use in such mines; for granting permits to sawmill owners to enter the reserves for the purpose of manufacturing such lumber as may be sold to them for the use of actual settlers in and adjacent to the reserves and to owners of mines located therein: *Provided*, That authority may be given to actual settlers who have no timber on their own claim to take from the reserves firewood, posts, poles, and fencing material necessary for their immediate personal use; for allowing the public to enter and cross the reserves; for granting to country commissioners rights of way for wagon roads in and across the reserves; for granting rights of way for irrigating ditches, flumes, and pipes, and for reservoir sites, under the terms of existing laws; and for permitting prospectors to enter the reserves to search for valuable minerals.

SEC. 3. That the forest reserves shall be open to the location of mining claims under the general mineral laws, and the owners of valid mining locations made and held in good faith are hereby authorized and permitted to fell and remove from such mining claims any timber growing thereon for actual mining purposes in connection with the particular claim from which the timber is felled and removed.

SEC. 4. That in cases in which land covered by unperfected bona fide claims, or by patents, are included within the limits of public forest reserves, the settlers or owners thereof may, if they so desire, relinquish the same to the Government, and may select in lieu thereof tracts of vacant land open to settlement, not exceeding in area the tracts covered by their claims or patents; and no charge shall be made in such cases for making the entries of record or issuing the patents to cover the tracts selected: *Provided*, That in cases of unperfected claims, the requirements of the laws respecting settlement, residence, improvements, etc., are complied with on the new claims, credit being allowed for the time spent on the relinquished claims. And the Secretary of the Interior is hereby authorized and directed to enter into negotiations with the land-grant railroad companies for the purpose of concluding agreements whereby said companies may relinquish to the United States title acquired by them to lands within their granted and indemnity limits, where such lands lie within the boundaries of forest reserves, accepting other unappropriated public lands in lieu thereof from the even-numbered sections within their granted and indemnity limits not embraced in forest reserves.

SEC. 5. That there shall be, and is hereby, established in the Department of the Interior a bureau of public forests. That such bureau shall consist of a director, an assistant director, a law clerk, a disbursing clerk, a chief clerk, and such clerical assistance as may be necessary, four inspectors, twenty-six head foresters, twenty-six assistant foresters, two hundred rangers, and such assistant rangers or temporary field force as may be found necessary at different seasons of the year.

SEC. 6. That the director shall have general charge of all matters relating to forests on the public domain, and shall be the president of an advisory forest board consisting of himself, the assistant director, and the four forest inspectors, and shall prepare and submit to the Secretary of the Interior for his approval such plans for the management of the public forests as may appear necessary, and shall be charged with the execution of the same. The assistant director shall be authorized to sign such letters, papers, and documents, and to perform such other duties as may be designated by the director, and shall act as director in the absence of that officer or in case of a vacancy in the office of director. The disbursing officer shall furnish a sufficient and satisfactory bond, and shall audit all accounts of the bureau, disburse all moneys in connection therewith, and shall report to the Secretary of the Treasury the amounts derived from the disposition of public timber. The forest reserves shall be divided into four divisions, each in charge of a forest inspector, under the

supervision of the director, whose stations shall be at the most convenient localities in their respective divisions, but they are to assemble in Washington when necessary as members of the advisory forest board. Each forest division shall be subdivided into such a number of districts as may most satisfactorily permit an efficient management, each district to be in charge of a head forester, under the control of an inspector. In the absence of an inspector, the director may designate a head forester of that division to act as inspector. There shall be an assistant forester for each district, who shall perform such duties as the head forester may direct, and in his absence act in his place, and who may also act as disbursing agent for his district. The head foresters may enter into contracts for the sale of public timber, subject to the approval of their superior officers, supervise the execution of the terms thereof, and notify the proper receiver of public moneys of the sums to be received. The head foresters shall also superintend the work of their assistants, rangers, and other subordinates in the execution of the laws and rules and regulations relating to the reservations, and shall approve all accounts and expenditures of their subordinates.

SEC. 7. That the director of the bureau of public forests, the assistant director, the inspectors, head foresters, and assistant foresters shall constitute a permanent forest corps, holding office during efficiency and good behavior, but subject to retirement at the age of sixty-four years, promotion to be governed by seniority of service; and they shall be appointed by the President, by and with the advice and consent of the Senate, as rapidly as men with the necessary education can be obtained.

SEC. 8. That officers of the forest corps shall be taken from graduates of the United States Military Academy or from graduates of other scientific schools, or universities having scientific courses, civilians first passing examinations satisfactory to the Civil Service Commission, but no discrimination being made between them; and the successful applicant shall be certified by the director of the bureau of public forests to the Secretary of the Interior for appointment by the President. Not less than four graduates of the United States Military Academy shall be sent abroad for instruction in forestry; and it shall be the duty of the Secretary of the Interior, on their return, to organize a school of forestry, in or near one of the great forest reserves, to which newly appointed officers of the forest corps shall be sent for instruction, and which may be open to civilians under such regulations as the Secretary of the Interior may prescribe: *Provided*, That one-half of the vacancies in the forest corps may be filled by the promotion, after satisfactory examination, of deserving men in the grade of ranger.

SEC. 9. That rangers shall be appointed, under civil-service rules, by the head forester under whom they are to act, and upon entering the service shall sign articles to serve for a period of five years. Assistant rangers or temporary field force may be employed by head foresters, as authorized by the director, for such periods as the exigences of the service may require.

SEC. 10. That the appointment of officers and employees not otherwise provided for in this act shall be made by the Secretary of the Interior under civil-service rules.

SEC. 11. That the forest corps shall receive the following annual compensation, with an increase of ten per centum for each period of five years' service: For the director, four thousand five hundred dollars; for the assistant director, four thousand dollars; for inspectors, three thousand five hundred dollars each; for head foresters, two thousand five hundred dollars each; for assistant foresters, two thousand dollars each: *Provided*, That on retirement said officers shall be entitled during the remainder of their lives to fifty per centum of the pay received by them at date of retirement. For the subordinate grades: For rangers, forty-five dollars per month, with an increase of ten per centum for each five years' service, and subsistence; for assistant rangers, at the rate of thirty dollars per month for the time actually employed, and subsistence.

SEC. 12. That all officers and employees of the bureau of public forests shall have authority to make arrests for the violation of the laws and regulations relating to the forest reserves, and any person so arrested shall be taken before the nearest United States commissioner, within whose jurisdiction the reservation is located, for trial. And upon sworn information by any competent person, any United States commissioner in the proper jurisdiction shall issue process for the arrest of any person charged with the violation of said laws and regulations; but nothing herein contained shall be construed as preventing the arrest by any officer of the United States without process of any person taken in the act of violating said laws and regulations.

SEC. 13. That every person who, either directly or indirectly, unlawfully appropriates, removes, cuts, injures, wastes, or causes the destruction, by fire, grazing, or herding of sheep or other live stock, or in any other manner whatsoever, of the timber, herbage, or other natural resources, or of the natural wonders or curiosities, or of any other public property whatsoever on or within any public lands embraced within such forest reserves shall, upon conviction, for every such offence be fined in a sum of not less than fifty dollars nor more than one thousand dollars, or shall be imprisoned not exceeding twelve months, or shall suffer both fine and imprisonment, in the discretion of the court; that in addition to the criminal proceedings herein provided, the United States shall be entitled to recover in civil suit the value of all property so unlawfully appropriated, injured, wasted, or destroyed, and shall also be entitled to recover in such cases nominal or exemplary damages. It is further provided that the United States should be entitled to the injunction of waste by way of prevention of trespass upon public property within such forest reservations.

SEC. 14. That every person who breaks into the close and unlawfully occupies, for any purpose whatsoever, public lands within such forest reservations shall be subject to ejectment and, upon conviction, shall for every such offence be fined in a sum not exceeding one thousand dollars, or shall be imprisoned not exceeding twelve months, or shall suffer both fine and imprisonment, in the discretion of the court.

SEC. 15. That the Secretary of the Interior shall cause the director of the Geological Survey to make topographical surveys of the forest lands set apart by Executive proclamation under section twenty-four of the act of Congress approved March third, eighteen hundred and ninety-one, and of such other forest lands as may be reserved from sale and entry under the authority of this act or any subsequent act of Congress: *And it is provided*, That there shall be appointed by the President a board which shall be designated the board of forest lands, consisting of one officer of the Corps of Engineers of the United States Army, one member of the United States Geological Survey, one member of the United States Coast Survey, and two persons not connected with the Government service: *And it is further provided*, That the members of the board of forest lands shall serve for five years, and that they shall be eligible for reappointment in the case that the duties for which this board is created are not completed at the expiration of their term of service: *And it is further provided*, That it shall be the duty of said board of forest lands to determine from the results of said surveys, and such other information as may be available, as rapidly as possible what reserved lands are more valuable for agriculture than for the production of timber, in order that such lands may be opened for settlement and entry by Executive proclamation. For the purpose of commencing and prosecuting this survey, there is hereby appropriated the sum of five hundred thousand dollars; and the Secretary of the Interior is hereby authorized to make such allotment from this sum as he may deem necessary to meet the expenses of said board of forest lands as herein provided: *And it is further provided*, That the members of the board of forest lands herein established shall be allowed a per diem in lieu of subsistence at a rate to be determined by the Secretary of the Interior, and that they shall be allowed actual necessary expenses for transportation.

No. 3.

A BILL for the management of the unreserved public timber lands and for the sale of the timber thereon.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That all public lands more valuable for the production of timber than for agriculture are hereby withdrawn from sale, settlement, and other disposition and shall be held for the growth and sale of the timber thereon.

SEC. 2. That until a survey of the public timber lands has been made and completed as provided for in section six a special affidavit shall be required in all cases where lands are disposed of under the homestead and other land laws, and in cases of indemnity selections, showing that the lands so entered or selected are more valuable for agriculture than for the production of timber: *Provided,* That such special affidavit shall not be required in cases of mineral location and entry; and that owners of valid mining locations made and held in good faith under the mining laws of the United States and the regulations thereunder are hereby authorized and permitted to fell and remove from such mining claims any timber growing thereon for actual mining purposes in connection with the particular claim from which the timber is felled or removed.

SEC. 3. That miners, prospectors, agriculturists, and other bona fide settlers, who have not a sufficient supply of timber on their own claims or lands for firewood, fencing, or building purposes, or for necessary use in developing the mineral and other natural resources of the lands owned or occupied by them, may be permitted, under regulations which the Secretary of the Interior shall prescribe, to procure timber from the public lands strictly for their individual use on their own claims or lands for the purposes enumerated in this section, but not for sale or disposal or use on other lands or by other persons; and the terms "miners," "prospectors," "agriculturists," and "other bona fide settlers," as herein used, shall be confined to apply strictly to individuals, and nothing herein shall be construed to extend the meaning of said terms to firms, companies, or corporations engaged in the wood or lumber business or in operating mines or claims.

SEC. 4. That the Secretary of the Interior is hereby authorized to sell timber from unreserved public lands, under such regulations as he may prescribe, and in such quantities as the demands of commerce and settlers may require: *Provided,* That the removal of such timber will not injuriously affect the water flow or other public interests: *Provided further,* That the value of the timber to be thus disposed of shall first be estimated and the timber thereafter be sold at public auction for not less than the appraised valuation: *Provided further,* That no sale shall take place until after notice thereof has been published for thirty days in at least two newspapers of general circulation in the State or Territory where the timber is growing, and that the timber so sold shall be removed within twelve months from date of sale, but that no part thereof shall be cut or removed until payment in full therefor has been made and receipt for such payment has been issued by the proper receiver of public moneys.

SEC. 5. That when a bureau of public forests is established in the Department of the Interior these lands shall be administered by such bureau in the same manner as the forest reserves.

SEC. 6. That the Secretary of the Interior shall cause the Director of the Geological Survey to make topographical surveys of the forest lands reserved for sale and entry under this act: *And it is provided,* That there shall be appointed by the President a board which shall be designated the board of forest lands, consisting of one officer of the Corps of Engineers, United States Army, one member of the United States Geological Survey, one member of the United States Coast Survey, and two persons not connected with the Government service: *And it is further provided,* That the members of the board of forest lands shall serve for five years, and that they shall be eligible for reappointment in case that the duties for which this board is

created are not completed at the expiration of their term of service: *And it is further provided,* That it shall be the duty of said board of forest lands to determine from the results of said surveys and other information as rapidly as possible what lands on the public domain are more valuable for agriculture than for forest uses, in order that such lands may be opened for settlement and entry by Executive proclamation. For the purpose of commencing and prosecuting this survey there is hereby appropriated the sum of five hundred thousand dollars, and the Secretary of the Interior is hereby authorized to make such an allotment from this sum as he may deem necessary to meet the expenses of said board of forest lands as herein provided: *And it is further provided,* That the members of the board of forest lands herein established shall be allowed a per diem in lieu of subsistence at a rate to be determined by the Secretary of the Interior, and that they shall be allowed actual necessary expenses for transportation.

SEC. 7. That all acts or parts of acts which are inconsistent with the provisions of this act are hereby repealed.

No. 4.

A BILL to set apart certain lands in the State of Washington as a public park, to be known as the Mount Ranier National Park.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby reserved, dedicated, and set apart as a public park, to be known and designated as the Mount Ranier National Park, for the benefit and enjoyment of the people, all that tract of land lying and being situate in the State of Washington, embraced within the following boundaries, to wit: Beginning at the southwest corner of township nineteen north, range seven east, Willamette base and meridian, Washington; thence easterly along the surveyed and unsurveyed township line between townships eighteen and nineteen north, to its point of intersection with the crest of the Cascade Range; thence in a southerly direction along the crest of said range of mountains to the Cowlitz Pass; thence down the right bank of the principal stream flowing from the Cowlitz Pass to its confluence with the Cowlitz River; thence down the middle of the channel of the Cowlitz River to the point where it will be intersected by the unsurveyed township line between townships twelve and thirteen north; thence westerly along said unsurveyed township line to the point for the southwest corner of township thirteen north, range seven east; thence northerly along the unsurveyed and surveyed range line between ranges six and seven east, subject to the proper offsets on the fourth standard parallel north, and on the township line between townships seventeen and eighteen north to the southwest corner of township nineteen north, range seven east, the place of beginning. And all persons who shall locate or settle upon or occupy the same, or any part thereof, except as hereafter provided, shall be considered trespassers and be removed therefrom.

SEC. 2. That said public park shall be under the exclusive control of the Secretary of the Interior, whose duty it shall be to make and publish, as soon as practicable, such rules and regulations as he may deem necessary or proper for the care and management of the same. Such regulations shall provide for the preservation from injury or spoliation of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition. The Secretary may, in his discretion, grant leases for building purposes, for terms not exceeding twenty-five years, of small parcels of ground at such places in said park as shall require the erection of buildings for the accommodation of visitors, all of the proceeds of said leases, and all other revenues that may be derived from any source connected with said park, to be expended under his direction in the management of the same and the construction of roads and bridle paths therein. He shall provide against the wanton destruction of the fish and game found within said park, and

against their capture or destruction for the purposes of merchandise or profit. He shall also cause all persons trespassing upon the same after the passage of this act to be removed therefrom, and, generally, is hereby authorized to take all such measures as shall be necessary or proper to fully carry out the objects and purposes of this act.

SEC. 3. That the Secretary of War, upon the request of the Secretary of the Interior, is hereby authorized and directed to make the necessary details of troops to prevent trespassers or intruders from entering the park for the purpose of destroying the game or objects of curiosity or the timber therein, or for any other purpose prohibited by law, and to remove such persons from the park if found therein.

SEC. 4. That the United States court for the district of Washington shall take cognizance of all violations of the terms of this act and of the rules and regulations of the Secretary of the Interior prescribed hereunder.

SEC. 5. That upon execution and filing with the Secretary of the Interior by the Northern Pacific Railway Company of proper deed releasing and reconveying to the United States the lands in the national park hereby created, which have been heretofore granted by the United States to said company, whether surveyed or unsurveyed, said company is hereby authorized to select in lieu thereof, and receive patent therefor, an equal quantity of unreserved nonmineral public land, so classified as nonmineral at the time of actual Government survey which has been or shall be made, and to which no adverse right or claim shall have attached or have been initiated at the time of the making of such selection, lying within any State into or through which the railroad of said Northern Pacific Railway Company runs.

No. 5.

A BILL to set apart certain lands in the Territory of Arizona as a public park, to be known as the Grand Canyon National Park.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby reserved, dedicated, and set apart as a public park, to be known and designated as the Grand Canyon National Park, for the benefit and enjoyment of the people, all of that part of the Grand Canyon Forest Reserve in the Territory of Arizona, created by the President's proclamation of February twentieth, eighteen hundred and ninety-three, lying north of the parallel of thirty-six degrees of north latitude; and all persons who shall locate or settle upon or occupy the same, or any part thereof, except as hereafter provided, shall be considered trespassers and be removed therefrom.

SEC. 2. That said public park shall be under the exclusive control of the Secretary of the Interior, whose duty it shall be to make and publish, as soon as practicable, such rules and regulations as he may deem necessary or proper for the care and management of the same. Such regulations shall provide for the preservation from injury or spoliation of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition. The Secretary may, in his discretion, grant leases for building purposes, for terms not exceeding twenty-five years, of small parcels of ground at such places in said park as shall require the erection of buildings for the accommodation of visitors, all of the proceeds of said leases, and all other revenues that may be derived from any source connected with said park, to be expended under his direction in the management of the same and the construction of roads and bridle paths therein. He shall provide against the wanton destruction of the fish and game found within said park, and against their capture or destruction for the purposes of merchandise or profit. He shall also cause all persons trespassing upon the same after the passage of this act to be removed therefrom, and, generally, is hereby authorized to take all such

measures as shall be necessary or proper to fully carry out the objects and purposes of this act.

SEC. 3. That the Secretary of War, upon the request of the Secretary of the Interior, is hereby authorized and directed to make the necessary details of troops to prevent trespassers or intruders from entering the park for the purpose of destroying the game or objects of curiosity or the timber therein, or for any other purpose prohibited by law, and to remove such persons from the park if found therein.

SEC. 4. That the United States court for the Territory of Arizona shall take cognizance of all violations of the terms of this act and of the rules and regulations of the Secretary of the Interior prescribed hereunder.

SEC. 5. That upon execution and filing with the Secretary of the Interior, by the Atlantic and Pacific Railroad Company, of proper deed releasing and reconveying to the United States the lands in the national park hereby created, which have been heretofore granted by the United States to said company, whether surveyed or unsurveyed, said company is hereby authorized to select in lieu thereof, and receive patent therefor, an equal quantity of unreserved nonmineral public land, so classified as nonmineral at the time of actual Government survey, which has been or shall be made, and to which no adverse right or claim shall have attached or have been initiated at the time of the making of such selection, lying within any State or Territory into or through which the railroad of said Atlantic and Pacific Railroad Company runs.

APPENDICES.

APPENDIX A.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888, and April 18, 1895.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy

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occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home Secretary may, however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its sessions next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes, and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special sessions may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election of officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected, on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot the members present may proceed to elect new members in the following manner: At each ballot each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the president and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

SEC 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the Academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the Academy and his name shall be dropped from the roll.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States, or, with the approval of the council, in State bonds or first-mortgage bonds on real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receive two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session; but no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date, in the records of the Academy, from the date of their presentation to the Academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred at the meeting at which they are read to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. The printing of the Academy shall be under the charge of the committee of publication, to consist of the home secretary and four other members to be named by the president, with the advice and consent of the council.

XIII. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XIV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XV. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVI. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make

scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XVIII. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XIX. At least sixty days before the election, the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XX. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXI. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXII. Any rule of the Academy may be amended, suspended, or repealed, on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is, ex officio, a member of all Government committees of the Academy.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.* HALL, A.

The Henry Draper Fund.

BARKER, G. F., *Chairman.* TROWBRIDGE, J.
NEWCOMB, S. WRIGHT, A. W.
YOUNG, C. A.

The J. Lawrence Smith Fund.

BRUSH, G. J., *Chairman.* JOHNSON, S. W.
HALL, A. PUMPELLY, R.
REMSEN, IRA.

The Benjamin Apthorp Gould Fund.

HALL, ASAPH. CHANDLER, S. C.
BOSS, LEWIS.

The Barnard Medal.

CHANDLER, C. F., *Chairman.* COMSTOCK, C. B.
BOSS, LEWIS. DANA, E. S.

The Wolcott Gibbs Fund.

JACKSON, C. L. REMSEN, IRA.
DROWN, T. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY 1, 1898.

		Date of election.
ABBE, CLEVELAND	*Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*Army Building, New York City.*	1872
AGASSIZ, ALEXANDER	*Cambridge, Mass.*	1866
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	*3909 Locust st., Philadelphia, Pa.*	1876
BARUS, CARL	*Providence, R. I.*	1892
BELL, A. GRAHAM	*Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*32 E. Thirty-first st., New York.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BRUSH, GEORGE J	*New Haven, Conn.*	1868
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	*16 Craigie st., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*Army Building, New York City.*	1884
COUES, ELLIOTT	*Washington, D. C.*	1877
CRAFTS, JAMES M	*59 Malboro' st., Boston, Mass.*	1872
DALL, WILLIAM H	*Washington, D. C.*	1897
DANA, EDWARD S	*New Haven, Conn.*	1884
DAVIDSON, GEORGE	*San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*San Antonio, Tex.*	1884

		Date of election.
ELKIN, WILLIAM L.	*New Haven, Conn.*	1895
EMMONS, SAMUEL F	*Washington, D. C.*	1892
FARLOW, W. G	*Cambridge, Mass.*	1879
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N.	*Washington D. C.*	1873
GOOCH, FRANCIS A	*New Haven, Conn.*	1897
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH	*Cambridge, Mass.*	1875
HALL, JAMES	*Albany, N. Y.*	——
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*West Nyack, N. Y.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*San Jose, Cal.*	1885
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L.	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W.	*New Haven, Conn.*	1866
KING, CLARENCE	*Century Club, New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LESLEY, J. PETER	*711 Walnut st., Philadelphia, Pa.*	——
MARSH, O. C	*New Haven. Conn.*	1874
MAYO-SMITH, RICHMOND	*Columbia College, New York City.*	1890
MENDENHALL, THOMAS C	*Worcester, Mass.*	1887
MICHAEL, ARTHUR	*College Hill, Mass.*	1889
MICHELSON, ALBERT A	*Chicago, Ill.*	1888
MINOT, CHARLES S.	*Boston, Mass.*	1897
MITCHELL, HENRY	*Nantucket, Mass.*	1885
MITCHELL, S. WEIR	*1524 Walnut st., Philadelphia, Pa.*	1865
MORLEY, EDWARD W	*Cleveland, Ohio.*	1897
MORSE, EDWARD S	*Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWCOMB, SIMON, U. S. N	*Washington, D. C.*	1869
PACKARD, A. S.	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*Milford, Pa.*	1877
PICKERING, EDWARD C.	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs Ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	*Abroad.*	——
ROGERS, WILLIAM A	*Waterville, Me.*	1885
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A.	*Johns Hopkins University, Baltimore, Md.*	1881
SARGENT, CHARLES S.	*Jamaica Plain, Mass.*	1895
SCHOTT, CHARLES A	*Washington, D. C.*	1872
SCUDDER, SAMUEL H.	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	*1600 Hamilton St., Philadelphia, Pa.*	1873
SMITH, SIDNEY I.	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
VERRILL, A. E.	*New Haven, Conn.*	1872

FOREIGN ASSOCIATES.

BUNSEN, ROBERT W	*Heidelberg.*
STRUVE, OTTO VON	*Pulkowa.*
STOKES, SIR GEORGE G	*Cambridge.*
HOOKER, SIR J. D	*Kew.*
LORD KELVIN	*Glasgow.*
AUWERS, ARTHUR	*Berlin.*
BERTRAND, J. L. F	*Paris.*
VIRCHOW, RUDOLPH VON	*Berlin.*
BERTHELOT, M. P. E	*Paris.*
KÖLLIKER, ALBERT VON	*Würzburg.*
RICHTHOFEN, F. VON	*Berlin.*
GEGENBAUR, CARL	*Heidelberg.*
RAMMELSBERG, K. F	*Berlin.*
LEUCKART, RUDOLPH	*Leipsic.*
LIE, SOPHUS	*Leipsic.*

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.
KARL ERNST VON BAER.
HENRY MILNE-EDWARDS.
MICHAEL FARADAY.
L. ELIE DE BEAUMONT.
SIR DAVID BREWSTER.
G. A. A. PLANA.
F. W. A. ARGELANDER.
FRIEDRICH WÖHLER.
J. B. DUMAS.
J. B. J. D. BOUSSINGAULT.
M. E. CHEVREUL.
MICHEL CHASLES.
SIR GEORGE B. AIRY.
J. C. ADAMS.
SIR RICHARD OWEN.
C. H. C. BURMEISTER.
ARTHUR CAYLEY.
T. H. HUXLEY.
HUGO GYLDÉN.
F. F. TISSERAND.
JULIUS VON SACHS.
SIR RODERICK I. MURCHISON.
VICTOR REGNAULT.
H. W. DOVE.
C. A. F. PETERS.
JUSTUS VON LIEBIG.
ALEXANDER BRAUN.
JOACHIM BARRANDE.
ADOLPHE WÜRTZ.
THEODORE VON OPPOLZER.
G. R. KIRCHOFF.
RUDOLPH CLAUSIUS.
JAMES P. JOULE.
CARLOS IBAÑEZ.
JEAN SERVAIS STAS.
ALPHONSE DE CANDOLLE.
A. W. HOFMANN.
BARON H. VON HELMHOLTZ.
K. F. W. LUDWIG.
LOUIS PASTEUR.
AUGUST KEKULÉ.
EMIL DU BOIS REYMOND.
J. J. SYLVESTER.
KARL WEIERSTRASS.

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1898.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1899.

LETTER

FROM THE

PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES,

TRANSMITTING

A REPORT OF THE OPERATIONS OF THE NATIONAL ACADEMY OF SCIENCES DURING THE YEAR 1898.

JANUARY 10, 1899.—Ordered to be printed.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 1, 1899.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences for the past year.

Very respectfully,

WOLCOTT GIBBS,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

ACT OF INCORPORATION.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. LeConte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division

into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 21, 1884.*

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

SESSIONS OF THE NATIONAL ACADEMY.

During the year 1898 the Academy held three sessions. The first was the regular annual session, held at Washington, April 19 to 22, inclusive. The second was a scientific session, held at New Haven, November 15 to 17. The third, a special session, held at New Haven, November 16, for the transaction of business.

ANNUAL MEETING.

[Held at Washington, April 19 to 22, 1898.]

The session was held in the Congressional Library, the President, Mr. Wolcott Gibbs, presiding.

The following-named members were present during the session: Abbe, Agassiz, Barker, Barus, Billings, Brewer, Bell, Brooke, Dall, Elkin, Emmons, Gibbs (W.), Gilbert, Gill, Gooch, Hague, Hall (A.), Hall (J.), Hastings, Hill (G. W.), Hyatt, Langley, Marsh, Mendenhall, Michelson, Newcomb, Putnam, Powell, Remsen, Rowland, Schott, Walcott, Welsh, White, Wright.

The President reported that no new business from Congress or from the departments had required the attention of the Academy since the publication of his last annual report to Congress, and stated that he had, as requested by the council, made suitable acknowledgment to Miss Alice Bache Gould for her munificent gift to the Academy.

REPORT OF THE TREASURER.

WASHINGTON, D. C., *April 19, 1898.*

The President of the National Academy of Sciences:

Sir: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 19, 1898:

Income.	General fund.	Bache fund.	Watson fund.	Henry Draper fund.	J. Lawrence Smith fund.	Wolcott Gibbs fund.	B. A. Gould fund.
To balance brought forward:							
Cash	$323.69	$3,275.45	$1,440.39	$1,241.96	$1,435.83	.....	.....
Invested	*a* 500.00	*b* 1,000.00	*a* 500.00 *c* 593.71	.....	*d* 596.57	.....	.....
Interest received during 1897-98	18.26	2,617.57	1,037.93	428.20	448.69	$137.18	.....
Tax paid by members	410.00	.....	.....	.....	.....	.....	.....
Total to be accounted for	1,251.95	6,893.02	3,572.03	1,670.16	2,481.09	137.18	.....
Disbursed, 1897-98	384.90	3,025.06	61.69	10.01	13.30	$137.18	.....
Balance:							
Cash	367.05	2,867.96	2,416.63	1,660.15	971.22	.....	.....
Invested	*a* 500.00	*b* 1,000.00	*a* 500.00 *c* 593.71	.....	*e* 1,496.57	.....	.....
Total accounted for	1,251.95	6,893.02	3,572.03	1,670.16	2,481.09	137.18	.....
Available (less obligations)	367.05	1,615.96	2,416.63	1,660.15	971.22	.....	.....

a District of Columbia bonds, 3.65 per cent.
b Dos Passos loan, 5 per cent.
c Earnshaw loan, 6 per cent.
d Webb loan, 5 per cent.
e Sisters of the Visitation, 4 per cent loan.

The treasurer's bond was renewed.

Very respectfully,

J. S. BILLINGS, *Treasurer.*

REPORT OF THE COMMITTEE ON SECURITIES.

The committee to examine the securities reported that they had examined the securities and papers deposited in the lock box of the Academy, at the building of the Washington Safe Deposit Company, and found them to correspond with the list furnished by the treasurer.

CLEVELAND ABBE.
THEODORE N. GILL.
ARNOLD HAGUE.

REPORT OF THE AUDITING COMMITTEE.

The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances correspond to the vouchers and accounts of the treasurer and are found correct.

CLEVELAND ABBE.
THEODORE N. GILL.
ARNOLD HAGUE.

LIST OF PAPERS PRESENTED AT THE APRIL SESSION.

The Coral Reefs of Fiji. A. Agassiz.

The Fiji Bololo. A. Agassiz and W. McM. Woodworth.

The Acalephs of Fiji. A. Agassiz and A. G. Mayer.

The Variation in Virulence of the Colon Bacillus. J. S. Billings.

Biographical Memoir of Edward D. Cope. Theo. Gill.

New Classification of Nautiloidea. Alpheus Hyatt.

A New Spectroscope. A. A. Michelson.

On the Hydrolysis of Acid Amides. Ira Remsen and E. E. Reid.

The Question of the Existence of Active Oxygen. (Read by title.) Ira Remsen and W. A. Jones.

On the Product Formed by the Action of Benzenesulphonchloride on Urea. (Read by title.) Ira Remsen and J. W. Lawson.

On Double Halides Containing Organic Bases. Ira Remsen.

McCrady's Gymnophthalmata of Charleston Harbor. W. K. Brooks.

Ballistic Galvanometry with a Countertwisted Torsion System. Carl Barus.

A Consideration of the Conditions Governing Apparatus for Astronomical Photography. Charles S. Hastings.

The Use of Graphic Methods in Questions of Disputed Authorship, with an Application to the Shakespeare-Bacon Controversy. T. C. Mendenhall.

A Method for Obtaining a Photographic Record of Absorption Spectra. A. W. Wright.

Theories of Latitude Variation. H. Y. Benedict. Presented by A. Hall.

Progress in the New Theory of the Moon's Motion. E. W. Brown. Introduced by S. Newcomb.

On the Variation of Latitude and the Aberration-Constant. Charles L. Doolittle. Introduced by S. C. Chandler.

A Curious Inversion in the Wave Mechanism of the Electromagnetic Theory of Light. Carl Barus.

AMENDMENT TO THE CONSTITUTION.

The following report from council on an amendment to the constitution was adopted by the Academy and the amendment will be voted on at the session in April, 1899:

SEC. 5. The Academy is to be divided into six standing committees. In this classification a member who is eminent in more than one subject may be assigned to a corresponding number of committees. The classification shall be the following:

1. Mathematics and Astronomy.
2. Physics and Engineering.
3. Chemistry.
4. Geology and Paleontology
5. Biology.
6. Anthropology.

In nominating for membership in the Academy, a statement must be made as to the subject or subjects in which the person nominated is eminent. Every nomination must be submitted, through the secretary, to all the members of the committee or committees representing the subject or subjects in which the person nominated is stated to be eminent; and, in order that his name may be brought before the Academy for election, he must receive the votes of a majority of the members of the committee or committees to which his name has been referred.

During the year ending January 1, 1899, the Academy lost by death Prof. William A. Rogers and Prof. James Hall.

The treasurer of the Academy, Dr. John S. Billings, having presented his resignation, Mr. Charles D. Walcott was elected in his place.

Messrs. Billings, Bowditch, Brush, Hague, Marsh, and Newcomb were elected members of the council for the ensuing academic year.

ELECTIONS.

No new members were elected at the annual session of the Academy, but the following named foreign associates were chosen: Adolph (Ritter von) Baeyer, Munich; David Gill, Cape Town; Felix Klein, Göttingen; Henri De Lacaze-Duthiers, Paris; Lord Lister, London; Henri Moissan, Paris; Henri Poincaré, Paris; Lord Rayleigh, London; Edouard Strasburger, Bonn; Edouard Suess, Vienna; Karl Alfred (Ritter von) Zittel, Munich.

REPORTS FROM TRUST FUNDS.

The trustees of the Lawrence Smith fund recommended that the sum of $1,000 be granted to the Yale University Observatory for the purpose of photographing the trails of meteors. Formal permission to make the appropriation was accorded by the Academy.

The board of directors of the Benjamin Apthorp Gould fund reported that having duly accepted their appointment they, at a first meeting held November 18, 1897, organized by the election of a president and secretary, and that, awaiting the accumulation of a sufficient accrued income from the fund, no appropriation had been made.

The board of directors of the Bache fund reported that the following appropriations have been made during the past year:

May 17. To Prof. H. A. Rowland, to continue investigations on the solar spectrum and the spectra of the elements	$1,000
May 25. To Prof. Lewis Boss, to continue investigations on the proper motions of the stars	1,000
May 25. To Dr. T. C. Mendenhall, for a determination of absolute gravity	500

SCIENTIFIC SESSION.

[Held in New Haven November 15 and 16, 1898.]

A scientific session, for the reading of papers only, having been called by the council, the Academy met at the Sheffield Scientific School, at New Haven. The President, Mr. Wolcott Gibbs, presiding.

The following-named members were present during the session: Barker, Barus, Bowditch, Brewer, Brush, Chittenden, Dana, Elkin, Emmons, Gibbs (J. W.), Gibbs (W.), Gooch, Hague, Hall, Hastings, Marsh, Michelson, Minot, Mitchell, Morley, Newcomb, Remsen, Rowland, Smith, Verrill, Woodward, Wright—27.

The following papers were presented:

Anatomy of *Nautilus pompilius*. (By title.) W. K. Brooks and L. E. Griffin.

On Solid Solutions of Colloidal Glass. C. Barus.

Three Phases of Vertebrate Development. Charles S. Minot.

Notes on Mammalian Embryology. Charles S. Minot.

The Influence of Alcohol and Alcoholic Fluids on Digestion. R. H. Chittenden.

On the Conditions Modifying the Excretion of Kynuremic Acid. Lafayette B. Mendel. (By invitation.)

Perturbations of Minerva, with a Preliminary Determination of its Orbit, by W. S. Eichelberger. (By title.) Presented by Simon Newcomb.

On a Series of Native Skulls from New Guinea. O. C. Marsh.

On the Reputed Prefrontal Bones in Recent Mammals. O. C. Marsh.

Sodium Tungstate as a Retainer for Boric Acid. F. A. Gooch and Louis Cleveland Jones.

The Ammonium-Magnesium Phosphate of Analysis. F. A. Gooch and Martha Austin.

The Chemical Composition of Tourmaline. S. L. Penfield. (By invitation.)

On the Nature and Origin of the Marine Fauna of Bermuda. A. E. Verrill.

On the Ability Possessed by Certain Animals to Recover after Complete Freezing. A. E. Verrill.

Further Researches on the Two Isomeric Chlorides of Orthosulphobenzoic Acid: A Study in Tautomerism. Ira Remsen.

On the Brecciated Fossiliferous Marble from Kishiu, Japan. O. C. Marsh.

On some Rare Antiquities from Mexico. O. C. Marsh.

Report upon Work in Spectrum Analysis Carried on by Help of the Bache Fund. H. A. Rowland.

Observations on the Zeeman Effect with the Echelon-Spectroscope. A. A. Michelson.

BUSINESS MEETING.

A business meeting of the Academy called by the Council to consider the report of the President to Congress, and such other business as might be presented, was held November 16. The President presided.

The following-named members were present: Barker, Bowditch, Brush, Chittenden, Emmons, Gibbs (J. W.), Gibbs (W.), Gooch, Hall,

Hastings, Michelson, Minot, Mitchell, Morley, Remsen, Rowland, Wright.

The recommendation of the council that the President be authorized to include in his annual report to Congress the proceedings of the present meeting, as well as those of the meeting at Washington in April, 1898, and also any matters relating to Government business that may be submitted to the Academy, was approved. The President presented and read a detailed outline of his report to Congress for the year ending January 1, 1899.

APPENDICES.

APPENDIX A.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home Secretary may,

however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its sessions next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes, and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special sessions may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election of officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected, on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. Proposed amendment to the constitution: "The Academy shall be divided into six standing committees. In this classification, a member who is eminent in more than one subject may be assigned to a corresponding number of committees. The classification shall be the following:

"1. Mathematics and Astronomy.

"2. Physics and Engineering.

"3. Chemistry.

"4. Geology and Paleontology.

"5. Biology.

"6. Anthropology.

"In nominating for membership in the Academy, a statement must be made as to the subject or subjects in which the person nominated is eminent. Every nomination must be submitted, through the secretary, to all the members of the committee or committees representing the subject or subjects in which the person nominated is stated to be eminent; and, in order that his name may be brought before the Academy

for election, he must receive the votes of a majority of the members of the committee or committees to which his name has been referred."

Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot the members present may proceed to elect new members in the following manner: At each ballot each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the President and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the President and acted on by the Academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the Academy with the recommendation that the per-

son thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the Academy and his name shall be dropped from the roll.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

APPENDIX B.

RULES.

I. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of viva voce votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected, by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented, which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year and referred with the accounts to the auditing committee.

IV. A committee of arrangements, consisting of five members, shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members, to arrange the business of each day, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to ascertain the length of time required for reading the several memoirs presented and, when it appears advisable, to recommend a limit of time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.

7. Other business.

8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session; but no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date, in the records of the Academy, from the date of their presentation to the Academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred at the meeting at which they are read to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. The printing of the Academy shall be under the charge of the committee of publication, to consist of the home secretary and four other members to be named by the president, with the advice and consent of the council.

XIII. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XIV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XV. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVI. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XVIII. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XIX. At least sixty days before the election the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XX. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXI. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXII. Any rule of the Academy may be amended, suspended, or repealed, on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the President is ex officio a member of all government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1899.

	Expiration of term.
GIBBS, WOLCOTT, *President*	April, 1901
HALL, ASAPH, *Vice-President*	April, 1903
AGASSIZ, A., *Foreign Secretary*	April, 1901
REMSEN, IRA, *Home Secretary*	April, 1903
WALCOTT, CHARLES D., *Treasurer*	April, 1904

ADDITIONAL MEMBERS OF COUNCIL, 1898-99.

BILLINGS, J. S.
BOWDITCH, H. P.
BRUSH, G. J.
HAGUE, A.
MARSH, O. C.
NEWCOMB, S.

COMMITTEES OF THE ACADEMY.

On Nominations of New Members.

[Showing the mode of classification of members under the proposed amendment to the constitution.]

1. Mathematics and Astronomy.
   - BOSS, L.
   - CHANDLER, S. C.
   - ELKIN, W. L.
   - GIBBS, J. W.
   - HALL, A.
   - HILL, G. W.
   - HOLDEN, E. S.
   - NEWCOMB, S.
   - PEIRCE, C. S.
   - PICKERING, E. C.
   - WOODWARD, R. S.
2. Physics and Engineering.
   - ABBE, C.
   - ABBOT, H. L.
   - BARKER, G. F.
   - BARUS, C.
   - BELL, A. G.
   - COMSTOCK, C. B.
   - DAVIDSON, G.
   - HASTINGS, C. S.
   - LANGLEY, S. P.
   - MENDENHALL, T. C.
   - MICHELSON, A. A.
   - MITCHELL, H.
   - MORLEY, E. W.
   - MORTON, H.
2. Physics and Engineering—Continued.
   - ROGERS, F.
   - ROOD, O. N.
   - ROWLAND, H. A.
   - SCHOTT, C. A.
   - SELLERS, W.
   - TROWBRIDGE, J.
   - WRIGHT, A. W.
3. Chemistry.
   - BRUSH, G. J.
   - CHANDLER, C. F.
   - CHITTENDEN, R. H.
   - CRAFTS, J. M.
   - DANA, E. S.
   - GIBBS, W.
   - GOOCH, F. A.
   - HILGARD, E. W.
   - HILL, H. B.
   - JACKSON, C. L.
   - JOHNSON, S. W.
   - MICHAEL, A.
   - MORLEY, E. W.
   - REMSEN, I.
4. Geology and Paleontology.
   - DALL, W. H.
   - DUTTON, C. E.
   - EMMONS, S. F.

4. Geology and Paleontology—Cont'd.
   - GILBERT, G. K.
   - HAGUE, A.
   - KING, C.
   - LESLEY, J. P.
   - PUMPELLY, R.
   - WALCOTT, C. D.
   - WHITE, C. A.

5. Biology.
   - AGASSIZ, A.
   - ALLEN, J. A.
   - BREWER, W. H.
   - BROOKS, W. K.
   - COUES, E.
   - FARLOW, W. G.
   - GILL, T. N.
   - GOODALE, G. L.
   - HYATT, A.
   - LE CONTE, J.

5. Biology—Continued.
   - MARSH, O. C.
   - MAYO-SMITH, R.
   - MORSE, E. S.
   - PACKARD, A. S.
   - PUTNAM, F. W.
   - SARGENT, C. S.
   - SCUDDER, S. H.
   - SMITH, S. I.
   - VERRILL, A. E.
   - WHITMAN, C. O.

6. Anthropology.
   - BILLINGS, J. S.
   - BOWDITCH, H. P.
   - MINOT, C. S.
   - MITCHELL, S. W.
   - POWELL, J. W.
   - WELCH, W. H.
   - WOOD, H. C.

On Weights, Measures, and Coinage.

MENDENHALL, T. C. — NEWCOMB, S.
MICHELSON, A. A. — PEIRCE, C. S.
YOUNG, C. A.

On the Election of Foreign Associates.

HALL, A. — MITCHELL, S. W.
AGASSIZ, A. — NEWCOMB, S.

On Publication.

THE HOME SECRETARY. — MENDENHALL, T. C.
BILLINGS, J. S. — NEWCOMB, S.
POWELL, J. W.

On Publications of the Academy.

GILL, T. N.

On the Relation of the Academy to the Government.

THE PRESIDENT. — BILLINGS, J. S.
VICE-PRESIDENT. — BRUSH, G. J.
SECRETARIES. — POWELL, J. W.

TRUST FUNDS.

Board of Direction of the Bache Fund.

GIBBS, WOLCOTT. — CHANDLER, S. C.
SCUDDER, S. H.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.* — HALL, A.

The Henry Draper Fund.

BARKER, G. F., *Chairman.* — TROWBRIDGE, J.
NEWCOMB, S. — WRIGHT, A. W.
YOUNG, C. A.

The J. Lawrence Smith Fund.

BRUSH, G. J., *Chairman.* JOHNSON, S. W.
HALL, A. PUMPELLY, R.
REMSEN, IRA.

The Benjamin Apthorp Gould Fund.

HALL, ASAPH. CHANDLER, S. C.
BOSS, LEWIS.

The Barnard Medal.

CHANDLER, C. F., *Chairman.* COMSTOCK, C. B.
BOSS, LEWIS. DANA, E. S.

The Wolcott Gibbs Fund.

JACKSON, C. L. REMSEN, IRA.
BROWN, T. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY 1, 1899.

		Date of election.
ABBE, CLEVELAND	*2017 I st. NW., Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*Army Building, New York City.*	1872
AGASSIZ, ALEXANDER	*Cambridge, Mass.*	1866
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	*3909 Locust st., Philadelphia, Pa.*	1876
BARUS, CARL	*Providence, R. I.*	1892
BELL, A. GRAHAM	*1331 Connecticut ave., Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*32 E. Thirty-first st., New York.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*418 Orange st., New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BRUSH, GEORGE J	*14 Trumbull st., New Haven, Conn.*	1868
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	*16 Craigie st., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*Army Building, New York City.*	1884
COUES, ELLIOTT	*1726 N st. NW., Washington, D. C.*	1877
CRAFTS, JAMES M	*59 Marlboro' st., Boston, Mass.*	1872
DALL, WILLIAM H	*Washington, D. C.*	1897
DANA, EDWARD S	*New Haven, Conn.*	1884
DAVIDSON, GEORGE	*530 California st., San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*San Antonio, Tex.*	1884
ELKIN, WILLIAM L	*New Haven, Conn.*	1895
EMMONS, SAMUEL F	*Washington, D. C.*	1892
FARLOW, W. G	*Cambridge, Mass.*	1879
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOOCH, FRANK A	*New Haven, Conn.*	1897
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH	*Cambridge, Mass.*	1875
HASTINGS, CHARLES S	*New Haven, Conn.*	1888

		Date of election.
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*West Nyack, N. Y.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*Century Association, New York City.*	1885
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*54 Trumbull st., New Haven, Conn.*	1866
KING, CLARENCE	*Century Association, New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LESLEY, J. PETER	*711 Walnut st., Philadelphia, Pa.*	——
MARSH, O. C	*New Haven, Conn.*	1874
MAYO SMITH, RICHMOND	*305 W. 77th st., New York City.*	1890
MENDENHALL, THOMAS C	*Worcester, Mass.*	1887
MICHAEL, ARTHUR	*Tufts College, Mass.*	1889
MICHELSON, ALBERT A	*Chicago, Ill.*	1888
MINOT, CHARLES S	*Boston, Mass.*	1897
MITCHELL, HENRY	*Nantucket, Mass.*	1885
MITCHELL, S. WEIR	*1524 Walnut st., Philadelphia, Pa.*	1865
MORLEY, EDWARD W	*Adelbert College, Cleveland, Ohio.*	1897
MORSE, EDWARD S	*P. O. Box 268, Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWCOMB, SIMON, U. S. N	*1620 P st. NW., Washington, D. C.*	1869
PACKARD, A. S	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*Milford, Pa.*	1876
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
ROGERS, FAIRMAN	*Abroad.*	——
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
SARGENT, CHARLES S	*Jamaica Plain, Mass.*	1895
SCHOTT, CHARLES A	*213 First st. SE., Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	*1600 Hamilton st., Philadelphia, Pa.*	1873
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
VERRILL, A. E	*New Haven, Conn.*	1872
WALCOTT, CHARLES D	*Washington, D. C.*	1896
WELCH, WILLIAM H	*935 St. Paul st., Baltimore, Md.*	1895
WHITE, CHARLES A	*Washington, D. C.*	1889
WHITMAN, CHARLES O	*Hyde Park Station, Chicago, Ill.*	1895
WOOD, HORATIO C	*1925 Chestnut st., Philadelphia, Pa.*	1879
WOODWARD, ROBERT S	*183 Claremont ave., Montclair, N. J.*	1896
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

DECEASED MEMBERS.

	Date of death.
*AGASSIZ, LOUIS	Dec. 14, 1873
*ALEXANDER, J. H	Mar. 2, 1867
*ALEXANDER, STEPHEN	June 25, 1883

*Biographical notices have been presented of those designated by an asterisk.

	Date of death.
*BACHE, ALEXANDER DALLAS	Feb. 14, 1867
*BAIRD, SPENCER F	Aug. 19, 1887
BARNARD, F. A. P	Apr. 27, 1889
BARNARD, J. G	May 14, 1882
BARTLETT, W. H. C	Feb. 11, 1893
*BROWN-SEQUARD, CHARLES E	Apr. 2, 1894
*CASEY, THOMAS L., U. S. A	Mar. 25, 1896
*CASWELL, ALEXIS	Jan. 8, 1887
*CHAUVENET, WILLIAM	Dec. 13, 1870
*CLARK, HENRY JAMES	July 1, 1873
*COFFIN, JAMES H	Jan. 6, 1873
COFFIN, J. H. C	Jan. 8, 1890
*COOK, GEORGE H	Sept. 22, 1889
COOKE, JOSIAH P	Sept. 3, 1894
*COPE, EDWARD D	Apr. 12, 1897
DALTON, J. C	Feb. 2, 1889
DANA, JAMES D	Apr. 14, 1895
*DAVIS, CHARLES H	Feb. 18, 1877
*DRAPER, HENRY	Nov. 20, 1882
*DRAPER, JOHN W	Jan. 4, 1882
*EADS, JAMES B	Mar. 8, 1887
*ENGELMANN, GEORGE	Feb. 4, 1884
*FERREL, WILLIAM	Sept. 18, 1891
*FRAZER, JOHN FRIES	Oct. 12, 1872
*GABB, WILLIAM M	May 30, 1878
GENTH, F. A	Feb. 2, 1893
*GILLISS, JAMES MELVILLE	Feb. 9, 1865
*GOODE, G. BROWN	Sept. 6, 1896
*GOULD, AUGUSTUS A	Sept. 15, 1866
GOULD, BENJAMIN A	Nov. 27, 1896
*GRAY, ASA	Jan. 30, 1888
*GUYOT, ARNOLD	Feb. 8, 1884
*HADLEY, JAMES	Aug. 1, 1864
*HALDEMAN, S. S	Sept. 20, 1880
HALL, JAMES	Aug. 8, 1898
*HAYDEN, F. V	Dec. 22, 1887
*HENRY, JOSEPH	May 13, 1878
*HILGARD, JULIUS E	May 8, 1891
*HITCHCOCK, EDWARD	Feb. 27, 1864
*HOLBROOK, J. E	Sept. 8, 1871
*HUBBARD, J. S	Aug. 16, 1863
*HUMPHREYS, A. A	Nov. 28, 1883
HUNT, T. STERRY	Feb. 12, 1892
*KIRKLAND, JARED P	Dec. 10, 1877
*LANE, J. HOMER	May 3, 1880
*LE CONTE, JOHN	Apr. 29, 1891
*LE CONTE, JOHN L	Nov. 15, 1883
LEA, MATTHEW C	Mar. 15, 1897
LEIDY, JOSEPH	Apr. 30, 1891
*LESQUEREUX, LEO	Oct. 25, 1889
LONGSTRETH, MIERS F	Dec. 27, 1891
*LOOMIS, ELIAS	Aug. 16, 1889
LOVERING, JOSEPH	Jan. 18, 1892
LYMAN, THEODORE	Sept. 10, 1897

* Biographical notices have been presented of those designated by an asterisk.

	Date of death.
*MAHAN, D. H	Sept. 16, 1871
*MARSH, G. P	July 23, 1882
MAYER, ALFRED M	July 13, 1897
*MEEK, F. B	Dec. 21, 1877
*MEIGS, M. C	Jan. 2, 1892
*MORGAN, LEWIS H	Dec. 14, 1881
NEWBERRY, J. S	Dec. 7, 1892
*NEWTON, H. A	Aug. 1, 1896
NEWTON, JOHN	May 1, 1895
*NORTON, WILLIAM A	Sept. 21, 1883
*OLIVER, JAMES E	Mar. 27, 1895
PETERS, C. H. F	July 18, 1890
*POURTALES, L. F	July 19, 1880
RODGERS, JOHN	May 5, 1882
ROGERS, ROBERT E	Sept. 7, 1884
ROGERS, WM. A	Mar. 1, 1898
*ROGERS, WILLIAM B	May 30, 1882
*RUTHERFURD, LEWIS M	May 30, 1892
*SAXTON, JOSEPH	Oct. 26, 1873
*SILLIMAN, BENJ., Sr	Nov. 24, 1864
SILLIMAN, BENJ., Jr	Jan. 14, 1885
*SMITH, J. LAWRENCE	Oct. 12, 1883
*STIMPSON, WILLIAM	May 26, 1873
*STRONG, THEODORE	Feb. 1, 1869
*SULLIVANT, W. S	Apr. 30, 1873
*TORREY, JOHN	Mar. 10, 1873
*TOTTEN, J. G	Apr. 22, 1864
*TROWBRIDGE, WILLIAM P	Aug. 12, 1892
TRUMBULL, JAMES H	Aug. 5, 1897
*TUCKERMAN, EDWARD	Mar. 15, 1886
WALKER, FRANCIS A	Jan. 5, 1897
*WARREN, G. K	Aug. 8, 1882
*WATSON, JAMES C	Nov. 23, 1880
*WATSON, SERENO	Mar. 9, 1892
*WINLOCK, JOSEPH	June 11, 1875
*WOODWARD, J. J., U. S. A	Aug. 17, 1884
*WORTHEN, A. H	May 6, 1888
*WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

AUWERS, ARTHUR	*Berlin.*
BAEYER, ADOLPH (RITTER VON)	*Munich.*
BERTHELOT, M. P. E	*Paris.*
BERTRAND, J. L. F	*Paris.*
BUNSEN, ROBERT W	*Heidelberg.*
GEGENBAUR, KARL	*Heidelberg.*
GILL, DAVID	*Cape Town.*
HOOKER, Sir J. D	*Kew.*
KELVIN (Lord)	*Glasgow.*
KLEIN, FELIX	*Göttingen.*
KÖLLIKER, ALBERT VON	*Würzburg.*
LACAZE-DUTHIERS, HENRI DE	*Paris.*

**Biographical notices have been presented of those designated by an asterisk.*

LIE, SOPHUS	*Leipzig.*
LISTER (Lord)	*London.*
MOISSAN, HENRI	*Paris.*
POINCARÉ, HENRI	*Paris.*
RAYLEIGH (Lord)	*London.*
RAMMELSBERG, K. F.	*Berlin.*
RICHTHOFEN, F. VON	*Berlin.*
STOKES, Sir GEORGE G	*Cambridge.*
STRASBURGER, EDOUARD	*Bonn.*
STRUVE, OTTO VON	*Pulkowa.*
SUESS, EDOUARD	*Vienna.*
VIRCHOW, RUDOLPH VON	*Berlin.*
ZITTEL, KARL ALFRED (RITTER VON)	*Munich*

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.
KARL ERNST VON BAER.
HENRY MILNE-EDWARDS.
MICHAEL FARADAY.
L. ELIE DE BEAUMONT.
SIR DAVID BREWSTER.
G. A. A. PLANA.
F. W. A. ARGELANDER.
FRIEDRICH WÖHLER.
J. B. DUMAS.
J. B. J. D. BOUSSINGAULT.
M. E. CHEVREUL.
MICHEL CHASLES.
SIR GEORGE B. AIRY.
J. C. ADAMS.
SIR RICHARD OWEN.
C. H. C. BURMEISTER.
ARTHUR CAYLEY.
T. H. HUXLEY.
HUGO GYLDÉN.
F. F. TISSERAND.
JULIUS VON SACHS.
SIR RODERICK I. MURCHISON.
VICTOR REGNAULT.
H. W. DOVE.
C. A. F. PETERS.
JUSTUS VON LIEBIG.
ALEXANDER BRAUN.
JOACHIM BARRANDE.
ADOLPHE WÜRTZ.
THEODORE VON OPPOLZER.
G. R. KIRCHOFF.
RUDOLPH CLAUSIUS.
JAMES P. JOULE.
CARLOS IBAÑEZ.
JEAN SERVAIS STAS.
ALPHONSE DE CANDOLLE.
A. W. HOFMANN.
BARON H. VON HELMHOLTZ.
K. F. W. LUDWIG.
LOUIS PASTEUR.
AUGUST KEKULÉ.
EMIL DU BOIS REYMOND.
J. J. SYLVESTER.
KARL WEIERSTRASS.

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S. Doc. 56——3

REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1899.

JANUARY 25, 1900.—Presented by Mr. HAWLEY and ordered to be printed.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 1, 1900.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences for the past year.

Very respectfully,

WOLCOTT GIBBS,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

ACT OF INCORPORATION.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division

into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations, and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 24, 1884.*

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

SESSIONS OF THE NATIONAL ACADEMY.

During the year 1899 the Academy held three sessions. The first was the regular annual session held at Washington, April 18 to 20, inclusive. The second was a scientific session held at New York, November 14 to 16. The third, a special session, held at New York, November 15, for the transaction of business.

ANNUAL MEETING.

[Held at Washington April 18 to 20, 1899.]

The session was held at Columbian University, the President, Mr. Wolcott Gibbs, presiding.

The following-named members were present during the session:

Abbe, Agassiz, Barker, Billings, Boss, Bowditch, Brewer, Brush, Brooks, Dall, Dana, Emmons, Gibbs W., Gill, Hague, Hall, Hyatt, Langley, Minot, Morse, Newcomb, Powell, Putnam, Remsen, Schott, Verrill, Walcott, Welch, White.

REPORTS.

The President reported that no business from Congress or from the Departments had required the attention of the Academy since the publication of his last annual report to Congress.

The home secretary reported as follows:

During the year ending January 1, 1899, the President's report for the year 1898 and the second and third Memoirs of Vol. VIII have been printed and distributed to members of the Academy, foreign associates, and correspondents. A number of packages containing publications of scientific bodies were received and stored, unopened, in the Smithsonian building. The Academy is indebted to the Smithsonian Institution for distributing its publications and storing its library.

The treasurer presented his report for the year as follows:

WASHINGTON, D. C., *April 18, 1899.*

The President of the National Academy of Sciences.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 18, 1899:

Income.	General fund.	Bache fund.	Watson fund.	Draper fund.	J. Lawrence Smith fund.	Wolcott Gibbs fund.	B. A. Gould fund.
Balance brought forward:							
Cash	$367.05	$2,867.96	$2,416.63	$1,660.15	$971.22	.....	.....
Invested	a500.00	b1,000.00	a500.00	.....	c1,496.57	.....	.....
Received interest during the year	18.26	2,172.15	1,205.30	430.25	363.89	.....	$915.00
Received members' tax	405.00	.....	.....	.....	.....	.....	.....
Received invested income returned	.....	.....	d593.71	.....	.....	.....	.....
Deficit	.....	.....	.....	.....	.....	$3.28	.....
Total to be accounted for.	1,290.31	6,040.11	4,715.64	2,090.40	2,831.68	3.28	915.00
Disbursed during the year	175.39	2,332.61	492.45	79.48	1,016.04	3.28	24.39
Balance:							
Cash	614.92	2,707.50	3,723.19	2,010.92	319.07	.....	890.61
Invested	a500.00	b1,000.00	a500.00	.....	c1,496.57	.....	.....
Total accounted for	1,290.31	6,040.11	4,715.64	2,090.40	2,831.68	3.28	915.00
Cash balance available, less obligations	614.92	955.50	3,723.19	2,010.92	319.07	.....	90.61
Uninvested	.....	.....	406.29	.....	.....	.....	.....

a District of Columbia 3.65 per cent bonds.
b Dos Passos loan, 5 per cent.
c Sisters of the Visitation loan, 4 per cent.
d Earnshaw loan, 6 per cent.

The treasurer's bond was renewed.

Respectfully,

CHAS. D. WALCOTT, *Treasurer.*

The treasurer's report was referred to an auditing committee, consisting of Messrs. Abbe, Gill, and Hague, who, after due examination, reported as follows:

The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances correspond to the vouchers and accounts of the treasurer, and are found correct.

CLEVELAND ABBE, *Chairman.*
ARNOLD HAGUE.
THEODORE N. GILL.

WASHINGTON, *April 18.*

The committee appointed to examine the securities and papers found in the box of the National Academy of Sciences, safe deposit company, reported that they had examined the securities and papers, as described, and found them to correspond with the lists.

CLEVELAND ABBE, *Chairman.*
ARNOLD HAGUE.
THEODORE N. GILL.

ELECTIONS.

Messrs. Billings, Bowditch, Brush, Hague, Langley, and Newcomb were elected members of the council.

Messrs. Charles E. Beecher, Edmund B. Wilson, George C. Comstock, Theodore W. Richards, and Edgar F. Smith were elected members of the Academy.

During the year 1899 the Academy lost by death Mr. Othniel Charles Marsh, an ex-president of the Academy, who died at New Haven March 18, and Mr. Elliott Coues, who died December 25. Sophus Lie, foreign associate, died February 18; Robert W. Bunsen, August 16; and Carl Friederich Rammèlsberg, December 28.

THE FOLLOWING AMENDMENT TO THE CONSTITUTION WAS ADOPTED:

SEC. 5. The Academy is to be divided into six standing committees. In this classification a member who is eminent in more than one subjeet may be assigned to a corresponding number of committees. The classification shall be the following:

1. Mathematics and astronomy.
2. Physics and engineering.
3. Chemistry.
4. Geology and Paleontology.
5. Biology.
6. Anthropology.

In nominating for membership in the Academy a statement must be made as to the subject or subjects in which the person nominated is eminent. Every nomination must be submitted through the secretary to all the members of the committee or committees representing the subject or subjects in which the person nominated is stated to be eminent, and in order that his name may be brought before the Academy for election, he must receive the votes of a majority of the members of the committee or committees to which his name has been referred.

REPORTS FROM TRUST FUNDS.

The President, on behalf of the board of directors of the Bache fund, reported that during the year ending January 1, 1899, the following appropriations had been made:

1899.

Mar. 7. To Dr. John S. Billings, for investigation of physiological effects of alcohol on the human body..... $250

Nov. 8. To Prof. Henry A. Rowland, for investigation of the solar spectrum, especially the completion of table of wave lengths and the determination of the elements whose presence in the sun causes them..... 700

Nov. 9. To Prof. A. S. Packard, in continuation of his investigation on the larval histories of the Bombycine moths, and for colored drawings of the same..... 100

Dr. Billings applied to the board of directors of the Bache fund for permission to use the sum of $250, being part of unused funds in his hands from a previous appropriation. The new appropriation was for an investigation on the effects of alcohol on metabolism in the human body, and was a contribution to the investigation being made by Professor Atwater under the direction of the subcommittee of the Committee of Fifty on the Physiological and Pathological Effects of Alcohol. Permission was granted by the board of directors, and on April 8 Dr. Billings returned to the treasurer the sum of $46.97 as unexpended. He also notified the treasurer that Dr. S. Weir Mitchell and himself would not use the appropriation of $1,000 made to them by the board in May, 1896, for the purpose of bacteriological research.

The directors of the Benjamin Apthorp Gould fund report that the following appropriations have been made by them:

To Prof. C. L. Doolittle the sum of $500, for a definitive reduction of the latitude observations made at the Sayre Observatory, South Bethlehem, Pa., from 1889 to 1895.

To Henry M. Parkhurst the sum of $300, for photometric stellar observations.

Mr. Newcomb, on behalf of the trustees of the Watson fund, moved that the fifth Watson medal be awarded to David Gill, Her Majesty's astronomer at the Cape of Good Hope, for his work in perfecting the application of the heliometer to astronomical measurements, which has resulted in an important advance in astronomy of precision, especially in the determination of parallaxes of the sun and stars and of the position of the planets.

The recommendation was approved by the Academy.

Mr. Barker made the following recommendation on behalf of the Committee on the Henry Draper fund.

The Committee on the Henry Draper fund hereby recommend the award of the Henry Draper medal to Prof. James E. Keeler, Director of the Lick Observatory, for his researches in spectroscopic astronomy.

GEORGE F. BARKER, *Chairman.*

The recommendation was approved by a unanimous vote.

The following report upon the progress of spectrum work, under the direction of Mr. Henry A. Rowland, by Mr. L. E. Jewell, was presented by Mr. Rowland:

REPORT UPON THE PROGRESS OF SPECTRUM WORK SINCE THE PUBLICATION OF THE PRELIMINARY TABLE OF WAVE LENGTHS, BY L. E. JEWELL.

The published table has been carefully gone over and compared with the original, and a *table of corrections* published, including the revision for identification of solar with metallic lines as far as they were completed at the time.

The work of identification has been revised for all except a few of the less important elements over the whole extent of "Rowland's Map," and carefully compared with the published table with identifications by Rowland upon two sets of maps.

Comparisons have also been made with the old set of plates from wave length 3,700 upward as far as the plates go.

New plates have been taken of the more important elements, extending to wave length 6,100 or 6,200. These plates are much superior to the old ones in all respects except fineness of grain, but in some cases are not quite so good as are many old plates, because of the increased street traffic near the laboratory and consequent vibration of the apparatus.

The new plates have all been carefully gone over and the lines due to impurities and ghosts carefully marked; also, data have been secured for eliminating the error of wave length due to motion in the line of sight of the earth and its rotation, upon all of the new plates.

The redetermination of coincidences has been completed for iron up to wave length 62 and for all other important elements, except on some two or three plates in the green and blue spectra of these elements. Some work of identification has been done visually in the spectroscope, but comparatively little as yet.

The number of new identifications made are about as many as were given in the original table; besides many errors have been detected (though these are for the most part of unimportant lines).

Most of the new identifications have been small and in many cases exceedingly faint solar lines. This has rendered the work exceedingly difficult and tedious, many of these solar lines not being visible upon the plates containing metallic spectra. As the fine-grained map plates of Rowland are upon a somewhat different scale, this difference has made much of the work difficult and laborious.

Quite a number of fine lines in the spectrum of titanium and chromium have been found to coincide with very faint lines in the solar spectrum, which were too faint to measure with accuracy, and, although nearly all were indicated in the original notes, they were not incorporated in the published table. These lines have been measured and included in the revised table.

A number of lines due to ruthenium have been found to be present in the ultra-violet solar spectrum. Many of the plates of yttrium, scandium, and other rare elements have been measured and some progress made toward the identification of their lines.

A redetermination has been carefully made of Rowland's estimate of the number of lines of each element present in the solar spectrum and their relative importance in the solar atmosphere.

There remains yet to be done a reexamination of plates of most elements from 3,000 to 3,700, and some of the plates in the blue and green.

Some more plates will yet have to be taken where the old ones are defective or where none were taken.

It is believed that this work can be finished some time next spring. The nature of the work renders it impossible to give beforehand any exact date.

LIST OF PAPERS PRESENTED AT THE APRIL SESSION.

Ophiura Brevispina. W. K. Brooks and Caswell Grave.

The Shadow of a Planet. A. Hall.

On the Tanner Deep Sea Tow Net. A. Agassiz.

On the Acalephs of the East Coast of the United States. A. Agassiz and A. G. Mayer.

On the Limestones of Fiji. E. C. Andrews; communicated by A. Agassiz.

On the Bololo of Fiji and Samoa. W. McM. Woodworth; communicated by A. Agassiz.

On the Diamond and Gold Mines of South Africa. A. Agassiz.

The Resulting Differences Between the Astronomic and Geodetic Latitudes and Longitudes in the Triangulation Along the Thirty-ninth Parallel. H. S. Pritchett; introduced by C. D. Walcott.

Progress in Surveying and Protection of the United States Forest Reserves. C. D. Walcott.

The Work of the Division of Forestry, Department of Agriculture. Gifford Pinchot; introduced by C. D. Walcott.

On the Development by Selection of Supernumerary Mammæ in Sheep. A. Graham Bell.

On Kites with Radial Wings. A. Graham Bell.

Remarks on the Work of the Nautical Almanac Office during the Years 1877–98 in the Field of Theoretical Astronomy. S. Newcomb.

Exhibition of Specimens of *Nautilus pompilius*. W. K. Brooks and L. E. Griffin.

SCIENTIFIC SESSION.

[Held in New York November 14 and 15, 1899.]

A scientific session for the reading of papers only having been called by the Council, the Academy met at Columbia University, New York, the President, Mr. Wolcott Gibbs, presiding:

The following-named members were present during the session: *Abbe, Barker, Bell, Beecher, Billings, Bowditch, Brewer, Brush,*

Chandler, C. F., Comstock, C. B., Dana, Emmons, Gibbs, W., Hague, Hastings, Holden, Mayo-Smith, Michelson, Newcomb, Peirce, Putnam, Richards, Rood, Verrill, Walcott, Wilson, Wood, Woodward, Wright.

The following papers were read:

TUESDAY.

Variations in Normal Color Vision. Ogden N. Rood.

The Time of Perception as a Measure of Difference in Intensity. (By invitation) J. McKeen Cattell.

Relations of Time and Space in Vision. (By invitation) J. McKeen Cattell.

The Electro-chemical Equivalents of Copper and Silver. Theodore William Richards.

Recent Results of the Henry Draper Memorial. Edward C. Pickering. Read by George F. Barker.

The Statical Properties of the Atmosphere. R. S. Woodward.

The Hydrogen Vacua of Dewar. George F. Barker.

A Direct Proof of the Effect on the Eulerian Cycle of an Inequality in the Equatorial Moments of Inertia of the Earth. R. S. Woodward.

WEDNESDAY.

The Map-coloring Problem. Charles S. Peirce.

Memoir of W. A. Rogers as a Physicist. E. W. Morley.

Report of the Delegates to the Wiesbaden Congress to consider the establishment of an International Scientific Association. Henry P. Bowditch.

BUSINESS MEETING.

A business meeting of the Academy, called by the Council to consider the report of the President to Congress and such other business as might be presented, was held November 15, the President presiding.

The recommendations of the Council that the President be authorized to include in his annual report to Congress the proceedings of the present meeting as well as those of the meeting at Washington in April, 1899, and also any matters relating to Government business which may be submitted to the Academy prior to the presentation of his report, was approved. The President read an outline of his report to Congress for the year ending January 1, 1900.

The President presented to the Academy papers relating to an international congress held at Wiesbaden in October last, and asked the approval of the Academy of his course in appointing delegates to attend the preliminary meeting. He stated that the cordial assent of the Council had been obtained before replies were made, conditionally approving the project.

The delegates appointed to attend the Wiesbaden conference on behalf of the National Academy of Sciences were Messrs. J. S. Billings, H. P. Bowditch, Simon Newcomb, Ira Remsen, Alexander Graham Bell. Of these, only Messrs. Bowditch, Newcomb, and Remsen were able to attend the meeting at Wiesbaden. After the reading of the papers the following resolutions were offered:

1. *Resolved*, That the Academy approves the action of the President in the appointment of delegates to the Congress at Wiesbaden in accordance with the invitation of the Royal Society of London and the Royal Prussian Academy of Sciences of Berlin.

2. *Resolved*, That the President be authorized to approve, in the name of the Academy, the plan of organization of the International Association of Academies adopted by the Congress at Wiesbaden and to signify the acceptance of membership therein by the Academy.

3. *Resolved*, That the President of the Academy be authorized to appoint, from time to time, the delegates to the International Association of Academies.

4. *Resolved*, That the International Association of Academies be requested to further define the powers and duties of a special international committee by the adoption of the following paragraphs:

Such international committees shall consist of delegates appointed by the constituent academies with special reference to their qualification to deal with the questions under consideration.

The first meeting of such a committee shall be called by the President of the International Association or by the President of the Council, and at this meeting each committee shall adopt rules for its own guidance.

Each international committee shall make a report, embodying such recommendations as it may think advisable, to the President of the International Council, who shall transmit the same to the constituent academies.

The President of the Council shall, however, have power, if he see fit, before transmitting such reports to the constituent academies, to submit the same to the Council, and this body shall have power to refer back the report to the committee for further consideration.

These resolutions were unanimously adopted.

THE ROYAL SOCIETY, BURLINGTON HOUSE,
London, W., April 14, 1899.

SIR: The Royal Society has frequently had occasion to take action in respect to scientific undertakings calling for the cooperation of several countries, and undertakings of this nature show a tendency to increase. The experience of the society has led to the belief that it would be very advantageous to the interests of science generally if some machinery could be devised by means of which suggestions made for international cooperation in scientific inquiries could be thoroughly discussed by the leading men of science from a purely scientific point of view, before definite proposals are made with a view to official action by the Governments of the countries concerned.

With this view the Royal Society has communicated with the leading scientific academies of Europe whose replies give much encouragement to the idea that it may be possible to establish an organization under which formal and regular meetings of

representatives of all leading scientific academies may be held for the purpose of discussing scientific matters calling for international cooperation, and by this means preparing the way for international action. The Council of the Royal Society regards this question as one of great importance, and I am to request you to bring it before your Academy, and to ask whether that body would be prepared to join such an organization if established, and to cooperate in arranging the details for inaugurating it upon a practical working basis.

I have the honor to be, very faithfully, yours,

LISTER,
President Royal Society.

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., U. S. A.

THE ROYAL SOCIETY, BURLINGTON HOUSE,
London, W., May 31, 1899.

SIR: On the 17th November of last year the president of the Royal Society addressed a letter to the Académie des Sciences, of Paris, the Reale Accademia dei Lincei, of Rome, and the Académie Imperiale des Sciences, of St. Petersburg, in reference to a proposal that the leading academies should meet at intervals to discuss matters which might demand international cooperation; and a similar letter was subsequently addressed to the National Academy of Sciences, of Washington.

The letter was written in consequence of what had taken place at a meeting of German academies at Göttingen in June of that year, at which representatives of the Royal Society were present; and we have communicated to a meeting of the same academies which has just been held at Munich the favorable replies which we have received from each of the academies whom we had addressed.

We now have the pleasure to inform you that the invitation to a meeting at Wiesbaden on October 9 and 10, which this letter accompanies, is a step toward carrying out the proposal in question, and we sincerely hope that your Academy will be able to take part in the meeting, which is intended to be a preliminary one for the purpose of discussing the mode in which such an association of academies can be best organized.

We are, sir, your obedient servants,

M. FOSTER,
ARTHUR W. RÜCKER,
Secretaries Royal Society.

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., U. S. A.

[Translation.]

ROYAL ACADEMY OF SCIENCES,
Berlin, June, 1899.

The Royal Prussian Academy of Sciences in Berlin is commissioned by the German academies assembled in Munich on the 23d of May of the present year, and also by an agreement with the Royal Society (of London), whose rules of procedure are here added, to invite the National Academy at Washington, for the purpose of founding an international association of learned societies to meet at Wiesbaden on the 9th and 10th of October of the present year for a constructive conference.

This invitation is extended at the same time to the royal societies of science in Göttingen and Leipzig; the Royal Academy of Sciences in Munich; the Academy of Sciences in Paris; the Imperial Academy of Sciences in St. Petersburg; the Reale Accademia dei Lincei in Rome; the National Academy of Sciences in Washington; and the Imperial Academy of Sciences in Vienna.

The object of the association is to support scientific undertakings which have been begun or recommended either by the assemblage of the united scientific bodies, or by a group of them, or by a single one of them, and to render mutually intelligible arrangements to facilitate scientific intercourse. The decision as to participation shall be left to each single body, as well as the ways and means for each particular case.

It will be the problem of the Wiesbaden conference to consult about the organization and business arrangement of this association and to decide upon the admission of other learned societies. A more precise programme will shortly be laid before the academies invited. It must be stated in advance that it is decided that for the Wiesbaden conference every academy may send at its pleasure a number of delegates to be decided by its own judgment, but the selections must be made according to academies. The language to be used in the proceedings is arbitrary. The protocols will be in German, English, or French.

It is proposed at this formative conference at Wiesbaden to allow the first working conference to follow in the year 1900, and that at Paris.

After the reception of the decisions and proposals in view, we beg for a definite statement as to the sending to the Wiesbaden conference, with the names of the delegates to be communicated to our bureau as above.

The Secretary, DIELS.

[Translation.]

ROYAL ACADEMY OF SCIENCES,
Berlin, June 13, 1899.

The Royal Prussian Academy of Sciences in Berlin has the honor, in continuation of its letter of invitation of the 1st of the present month, to a conference in Wiesbaden on the 9th and 10th of October of the present year in behalf of the formation of an international association of learned societies, to ask your attention respectfully to a plan preliminarily formulated by the Academies of Berlin, Göttingen, Leipzig, Munich, and Vienna for its establishment. Our academy will in the shortest possible time send further suggestions on the details of the organization and conduct of business, which shall serve as introductions to the discussion at the Wiesbaden conference. But we beg you kindly to inform us at once whether the National Academy at Washington is disposed in principle to take part in the conference by sending representatives, and as soon as possible to give us their names and addresses.

The Secretary, DIELS.

[Translation.]

ROYAL ACADEMY OF SCIENCES,
Berlin, July 24, 1899.

To the National Academy of Sciences at Washington:

The Royal Academy of Sciences, which hopes to greet the delegates of your academy on the 9th and 10th of October at the conference at Wiesbaden, sends with this a proposal for the organization and conduct of business which may serve as a foundation for business. More precise information as to place and time of meeting will be communicated later to the delegates. For this purpose the academy asks for the names and addresses of the delegates, which you will please to send until, at latest, the end of September, to the bureau of the Royal Academy of Sciences, Berlin N. W., Universitätsstrasse.

In conclusion, the academy has the honor to inform you that, on its part, it has appointed as delegate its members, Messrs. Auwers, Virchow, and Diels.

The Secretary,

DIELS.

The NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., U. S. A.

PLAN FOR THE FOUNDATION OF AN INTERNATIONAL ASSOCIATION OF LEARNED SOCIETIES.

1. The formation of an international association of the larger learned societies of the world is regarded as expedient and as likely to prove of service to the advancement of science.

2. The object of this association is to support scientific enterprises undertaken or recommended by the united societies in common, or by a group of the same, or by any individual society, and, further, to make arrangements for facilitating international scientific intercourse. Each society shall, as regards any particular undertaking, reserve to itself the right of deciding whether it will participate or not.

3. At the conference to be held at Wiesbaden the organization of the association and its business details will be more fully discussed, deciding at the same time whether periodical meetings, say every three or five years, shall be held, or whether such meetings shall take place at irregular intervals as occasion requires.

4. The resolutions of the Wiesbaden Conference will be submitted to the individual societies for their approval and sanction. The societies will then, by the end of the year 1899, definitely inform some central authority appointed by the conference whether they intend or not to join.

5. Each society is free to withdraw from the association at any time.

6. The Royal Academy of Sciences (Berlin), in conjunction with the Royal Society (London), has invited the following bodies (here arranged in alphabetical order) to attend the Wiesbaden Conference:

1. Königliche Gesellschaft der Wissenschaften at Göttingen.
2. Königliche Gesellschaft der Wissenschaften at Leipzig.
3. Königliche Akademie der Wissenschaften at Munich.
4. Académie des Sciences at Paris.
5. Académie Impériale des Sciences at St. Petersburg.
6. Reale Accademia dei Lincei at Rome.
7. Kaiserliche Akademie der Wissenschaften at Vienna.
8. National Academy at Washington.

7. The question of the eventual admission of other societies will be discussed at the Wiesbaden meeting.

8. Each body will exercise its own judgment concerning the number of representatives to be sent to Wiesbaden. At the voting the representatives of each society will have but a joint vote.

9. The language to be used at the conference will be optional. The minutes will be drawn up in English, French, and German.

10. The Royal Society proposes that the first official meeting of the association be held in the year 1900 in Paris.

All communications referring to the Wiesbaden Conference are to be directed to the "Bureau der Königlichen Akademie der Wissenschaften," Berlin N. W., Universitätsstrasse 8.

CONFERENCE AT WIESBADEN.

OCTOBER 9, 10, 1899.

LIST OF DELEGATES.

1. Königliche Preussische Akademie der Wissenschaften, Berlin, Auwers, Virchow, Diels.

2. Königliche Gesellschaft der Wissenschaften, Göttingen, Ehlers, Leo.

3. Königliche Sächsische Gesellschaft der Wissenschaften, Leipzig, Windisch, Wislicenus.

4. Royal Society, London, Sir M. Foster, Rücker, Armstrong, Schuster.

5. Königliche Bayerische Akademie der Wissenschaften, München, von Zittel, Bechmann, Dyck, von Sicherer.

6. Académie des Sciences, Paris, Darboux, Moissan.

7. Kaiserliche Akademie der Wissenschaften, St. Petersburg, Famintzine, Salemann.

8. National Academy of Sciences, Washington, Newcomb, Billings, Remsen, Bowditch, Bell.

9. Kaiserliche Akademie der Wissenschaften, Wien, von Hartel, Mussafia, von Lang, Lieben. Substitutes: Gomperz, Toldt.

Messrs. Bell and Billings were unable to attend the meeting.

PLAN FOR THE ORGANIZATION OF AN INTERNATIONAL SCIENTIFIC ASSOCIATION ADOPTED AT THE WIESBADEN CONFERENCE.

1. The members of the national academies mentioned in the "Plan for the foundation of an international association of learned societies" (Berlin, June, 1899), together with those of such other academies as may be chosen by a majority vote of the academies represented at the preliminary conference in Wiesbaden in October, 1899, shall constitute an international scientific association.

2. The first meeting of the association shall be held in Paris, in 1900, and its subsequent meetings shall be held at such times and places as may be then or thereafter determined.

3. By a two-thirds vote of the association, each academy voting as a unit, representative academies of other nations may be admitted to membership in the association.

4. The objects of the association are:

(*a*) To promote and make preliminary preparations for work requiring international cooperation for its prosecution.

(*b*) To facilitate intercourse, both professional and social, between scientific men of all countries.

5. The governing body of the association shall be an international council composed of one representative from each constituent academy.

6. The council shall hold its first meeting at such time and place as may be determined at the meeting of the association in 1900 and shall make rules for its own organization and guidance, including the transaction of business by correspondence.

7. For the purpose of considering and framing recommendations concerning scientific inquiries calling for international cooperation, special international committees shall, upon recommendation of one or more constituent academies, be instituted either at a general meeting of the association or, when necessary during the intervals between such meetings, by the international council.

8. Such international committees shall consist of delegates appointed by the constituent academies with special reference to their qualification to deal with the questions under consideration.

9. The first meeting of such a committee shall be called by the president of the international association, or by the president of the council, and at this meeting each committee shall adopt rules for its own guidance.

10. Each international committee shall make a report, embodying such recommendations as it may think advisable, to the president of the international council, who shall transmit the same to the constituent academies.

11. The president of the council shall, however, have power, if he see fit, before transmitting such reports to the constituent academies, to submit the same to the council, and this body shall have power to refer back the report to the committee for *further consideration*.

12. *For the* transaction of business the president of the council shall be authorised *employ a secretary*, whose compensation, as well as other necessary office expenses, *be provided* for by contributions from the constituent academies.

APPENDICES.

APPENDIX A.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895; April 20, 1899.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings, and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home Secretary may,

however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the Academy.

SEC. 3. The president of the Academy, or, in case of his absence or inability to act, the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects, and report thereon to the Academy at its sessions next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments, not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting shall be recorded in the minutes, and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special sessions may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election of officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected, on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. The Academy shall be divided into six standing committees. In this classification, a member who is eminent in more than one subject may be assigned to a corresponding number of committees. The classification shall be the following:

1. Mathematics and Astronomy.
2. Physics and Engineering.
3. Chemistry.
4. Geology and Paleontology.
5. Biology.
6. Anthropology.

In nominating for membership in the Academy, a statement must be made as to the subject or subjects in which the person nominated is eminent. Every nomination must be submitted, through the secretary, to all the members of the committee or committees representing the subject or subjects in which the person nominated is stated to be eminent; and, in order that his name may be brought before the Academy

for election, he must receive the votes of a majority of the members of the committee or committees to which his name has been referred.

Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot the members present may proceed to elect new members in the following manner: At each ballot each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members to be appointed for that purpose by the President and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the President and acted on by the Academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the Academy with the recommendation that the per-

son thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the Academy and his name shall be dropped from the roll.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States, or, with the approval of the council, in State bonds or first-mortgage bonds on real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receive two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

APPENDIX B.

RULES.

I. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of viva voce votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected, by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented, which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year and referred with the accounts to the auditing committee.

IV. A committee of arrangements, consisting of five members, shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members, to arrange the business of each day, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to ascertain the length of time required for reading the several memoirs presented and, when it appears advisable, to recommend a limit of time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.

7. Other business.

8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session; but no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date, in the records of the Academy, from the date of their presentation to the Academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

XI. Papers from persons not members read betore the Academy and intended for publication shall be referred at the meeting at which they are read to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. The printing of the Academy shall be under the charge of the committee of publication, to consist of the home secretary and four other members to be named by the president, with the advice and consent of the council.

XIII. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XIV. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XV. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XVI. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVII. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Government, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XVIII. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XIX. At least sixty days before the election the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XX. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XXI. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXII. Any rule of the Academy may be amended, suspended, or repealed, on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the President is ex officio a member of all government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1900.

	Expiration of term.
GIBBS, WOLCOTT, *President*	April, 1901.
HALL, ASAPH, *Vice-President*	April, 1903.
AGASSIZ, A., *Foreign Secretary*	April, 1901.
REMSEN, IRA, *Home Secretary*	April, 1903.
WALCOTT, CHARLES D., *Treasurer*	April, 1904.

ADDITIONAL MEMBERS OF COUNCIL, 1900.

BILLINGS, J. S.
BOWDITCH, H. P.
BRUSH, G. J.
HAGUE, A.
LANGLEY, S. P.
NEWCOMB, S.

COMMITTEES OF THE ACADEMY.

On nominations of new members.

1. Mathematics and Astronomy.
   - ABBE, C.
   - BOSS, L.
   - CHANDLER, S. C.
   - COMSTOCK, G. C.
   - DAVIDSON, G.
   - ELKIN, W. L.
   - HALL, A.
   - HILL, G. W.
   - HOLDEN, E. S.
   - NEWCOMB, S.
   - PEIRCE, C. S.
   - PICKERING, E. C.
   - WOODWARD, R. S.
   - YOUNG, C. A.
2. Physics and Engineering.
   - ABBE, C.
   - ABBOT, H. L.
   - BARKER, G. F.
   - BARUS, C.
   - BELL, A. G.
   - COMSTOCK, C. B.
   - GIBBS, J. W.
   - HASTINGS, C. S.
   - LANGLEY, S. P.
   - MENDENHALL, T. C
   - MICHELSON, A. A.
   - MITCHELL, H.
   - MORLEY, E. W.
   - MORTON, H.
2. Physics and Engineering—Continued.
   - PICKERING, E. C.
   - ROGERS, F.
   - ROOD, O. N.
   - ROWLAND, H. A.
   - SCHOTT, C. A.
   - SELLERS, W.
   - TROWBRIDGE, J.
   - WRIGHT, A. W.
3. Chemistry.
   - BARKER, G. F.
   - BRUSH, G. J.
   - CHANDLER, C. F.
   - CHITTENDEN, R. H.
   - CRAFTS, J. M.
   - DANA, E. S.
   - GIBBS, W.
   - GOOCH, F. A.
   - HILGARD, E. W.
   - HILL, H. B.
   - JACKSON, C. L.
   - JOHNSON, S. W.
   - MICHAEL, A.
   - MORLEY, E. W.
   - REMSEN, I.
   - RICHARDS, T. W.
   - SMITH, E. F.
4. Geology and Paleontology.
   - BEECHER, C. E.
   - DALL, W. H.

4. Geology and Paleontology—Cont'd.
   - DUTTON, C. E.
   - EMMONS, S. F.
   - GILBERT, G. K.
   - HAGUE, A.
   - KING, C.
   - LE CONTE, J.
   - LESLIE, J. P.
   - PUMPELLY, R.
   - WALCOTT, C. D.
   - WHITE, C. A.

5. Biology.
   - AGASSIZ, A.
   - ALLEN, J. A.
   - BOWDITCH, H. P.
   - BREWER, W. H.
   - BROOKS, W. K.
   - CHITTENDEN, R. H.
   - DALL, W. H.
   - FARLOW, W. G.
   - GILL, T. N.
   - GOODALE, G. L.
   - HYATT, A.
   - MINOT, C. S.

5. Biology—Continued.
   - MORSE, E. S.
   - PACKARD, A. S.
   - PUTNAM, F. W.
   - SARGENT, C. S.
   - SCUDDER, S. H.
   - SMITH, S. I.
   - VERRILL, A. E.
   - WALCOTT, C. D.
   - WELCH, W. H.
   - WHITE, C. A.
   - WHITMAN, C. O.
   - WILSON, E. B.
   - WOOD, H. C.

6. Anthropology.
   - BILLINGS, J. S.
   - MAYO-SMITH, R.
   - MINOT, C. S.
   - MITCHELL, S. W.
   - MORSE, E. S.
   - POWELL, J. W.
   - PUTNAM, F. W.
   - WELCH, W. H.

On Weights, Measures, and Coinage.

MENDENHALL, T. C. — NEWCOMB, S.
MICHELSON, A. A. — PEIRCE, C. S.
YOUNG, C. A.

On the Election of Foreign Associates.

HALL, A. — MITCHELL, S. W.
AGASSIZ, A. — NEWCOMB, S.

On Publications of the Academy.

GILL, T. N.

TRUST FUNDS.

Board of Direction of the Bache Fund.

GIBBS, WOLCOTT. — CHANDLER, S. C.
SCUDDER, S. H.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.* — HALL, A.
BOSS, L.

The Henry Draper Fund.

BARKER, G. F., *Chairman.* — TROWBRIDGE, J.
NEWCOMB, S. — WRIGHT, A. W.
YOUNG, C. A.

The J. Lawrence Smith Fund.

BRUSH, G. J., *Chairman.* — JOHNSON, S. W.
HALL, A. — PUMPELLY, R.
REMSEN, IRA.

The Benjamin Apthorp Gould Fund.

HALL, ASAPH. CHANDLER, S. C.
BOSS, LEWIS.

The Barnard Medal.

BILLINGS, J. S., *Chairman.* ROWLAND, H. A.
BOWDITCH, H. P. ROOD, O. N.
CHANDLER, S. C. JACKSON, C. L.
NEWCOMB, S.

The Wolcott Gibbs Fund.

JACKSON, C. L. REMSEN, IRA.
DROWN, T. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY 1, 1900.

		Date of election.
ABBE, CLEVELAND	*2017 I st. NW., Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*Army Building, New York City.*	1872
AGASSIZ, ALEXANDER	*Cambridge, Mass.*	1866
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	*3909 Locust st., Philadelphia, Pa.*	1876
BARUS, CARL	*Providence, R. I.*	1892
BEECHER, CHARLES E	*New Haven, Conn.*	1899
BELL, A. GRAHAM	*1331 Connecticut ave., Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*32 E. Thirty-first st., New York.*	1883
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*418 Orange st., New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BRUSH, GEORGE J	*14 Trumbull st., New Haven, Conn.*	1868
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	*16 Craigie st., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*Army Building, New York City.*	1884
COMSTOCK, GEORGE C	*Washburn Observatory, Madison, Wis.*	1899
CRAFTS, JAMES M	*59 Marlboro' st., Boston, Mass.*	1872
DALL, WILLIAM H	*Washington, D. C.*	1897
DANA, EDWARD S	*New Haven, Conn.*	1884
DAVIDSON, GEORGE	*2221 Washington st., San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Ordnance Office, War Dep't, Washington, D. C.*	1884
ELKIN, WILLIAM L	*New Haven, Conn.*	1895
EMMONS, SAMUEL F	*Washington, D. C.*	1892
FARLOW, W. G	*Cambridge, Mass.*	1879
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOOCH, FRANK A	*New Haven, Conn.*	1897
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH	*12 Kirkland Place, Cambridge, Mass.*	1875
HASTINGS, CHARLES S	*New Haven, Conn.*	1889

		Date of election.
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*West Nyack, N. Y.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*4 E. 43d st., New York City.*	1885
HYATT, ALPHEUS	*Soc. of Nat. History, Boston, Mass.*	1875
JACKSON, CHARLES L	*6 Boylston Hall, Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*54 Trumbull st., New Haven, Conn.*	1866
KING, CLARENCE	*Century Association, New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LESLEY, J. PETER	*711 Walnut st., Philadelphia, Pa.*	——
MAYO-SMITH, RICHMOND	*305 W. 77th st., New York City.*	1890
MENDENHALL, THOMAS C	*Worcester, Mass.*	1887
MICHAEL, ARTHUR	*Tufts College, Mass.*	1889
MICHELSON, ALBERT A	*Chicago, Ill.*	1888
MINOT, CHARLES S	*Boston, Mass.*	1897
MITCHELL, HENRY	*Nantucket, Mass.*	1885
MITCHELL, S. WEIR	*1524 Walnut st., Philadelphia, Pa.*	1865
MORLEY, EDWARD W	*Adelbert College, Cleveland, Ohio.*	1897
MORSE, EDWARD S	*P. O. Box 268, Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWCOMB, SIMON, U. S. N	*1620 P st. NW., Washington, D. C.*	1869
PACKARD, A. S	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*Milford, Pa.*	1876
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
RICHARDS, THEODORE W	*Cambridge, Mass.*	1899
ROGERS, FAIRMAN	*Abroad.*	——
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
SARGENT, CHARLES S	*Jamaica Plain, Mass.*	1895
SCHOTT, CHARLES A	*212 First st. SE., Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	*1600 Hamilton st., Philadelphia, Pa.*	1873
SMITH, EDGAR F	*Philadelphia, Pa.*	1899
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
VERRILL, A. E	*New Haven, Conn.*	1872
WALCOTT, CHARLES D	*Washington, D. C.*	1896
WELCH, WILLIAM H	*935 St. Paul st., Baltimore, Md.*	1895
WHITE, CHARLES A	*Washington, D. C.*	1889
WHITMAN, CHARLES O	*University of Chicago, Chicago, Ill.*	1895
WILSON, EDMUND B	*Columbia University, New York City.*	1899
WOOD, HORATIO C	*1925 Chestnut st., Philadelphia, Pa.*	1879
WOODWARD, ROBERT S	*183 Claremont ave., Montclair, N. J.*	1896
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

DECEASED MEMBERS.

	Date of death.
*Agassiz, Louis	Dec. 14, 1873
*Alexander, J. H	Mar. 2, 1867
*Alexander, Stephen	June 25, 1883
*Bache, Alexander Dallas	Feb. 14, 1867
*Baird, Spencer F	Aug. 19, 1887
Barnard, F. A. P	Apr. 27, 1889
Barnard, J. G	May 14, 1882
Bartlett, W. H. C	Feb. 11, 1893
*Brown-Sequard, Charles E	Apr. 2, 1894
*Casey, Thomas L., U. S. A	Mar. 25, 1896
*Caswell, Alexis	Jan. 8, 1887
*Chauvenet, William	Dec. 13, 1870
*Clarke, Henry James	July 1, 1873
*Coffin, James H	Jan. 6, 1873
*Coffin, J. H. C	Jan. 8, 1890
*Cook, George H	Sept. 22, 1889
*Cooke, Josiah P	Sept. 3, 1894
*Cope, Edward D	Apr. 12, 1897
Coues, Elliott	Dec. 25, 1899
Dalton, J. C	Feb. 2, 1889
Dana, James D	Apr. 14, 1895
*Davis, Charles H	Feb. 18, 1877
*Draper, Henry	Nov. 20, 1882
*Draper, John W	Jan. 4, 1882
*Eads, James B	Mar. 8, 1887
*Engelman, George	Feb. 4, 1884
*Ferrel, William	Sept. 18, 1891
*Frazer, John Fries	Oct. 12, 1872
*Gabb, William M	May 30, 1878
Genth, F. A	Feb. 2, 1893
*Gilliss, James Melville	Feb. 9, 1865
*Goode, G. Brown	Sept. 6, 1896
*Gould, Augustus A	Sept. 15, 1866
Gould, Benjamin A	Nov. 27, 1896
*Gray, Asa	Jan. 30, 1888
*Guyot, Arnold	Feb. 8, 1884
*Hadley, James	Aug. 1, 1864
*Haldeman, S. S	Sept. 20, 1880
Hall, James	Aug. 8, 1898
*Hayden, F. V	Dec. 22, 1887
*Henry, Joseph	May 13, 1878
*Hilgard, Julius E	May 8, 1891
*Hitchcock, Edward	Feb. 27, 1864
*Holbrook, J. E	Sept. 8, 1871
*Hubbard, J. S	Aug. 16, 1863
*Humphries, A. A	Nov. 28, 1883
Hunt, T. Sterry	Feb. 12, 1892
*Kirkland, Jared P	Dec. 10, 1877
*Lane, J. Homer	May 3, 1880
*Le Conte, John	Apr. 29, 1891

* Biographical notices have been presented of those designated by an asterisk.

	Date of death.
*Le Conte, John L	Nov. 15, 1883
Lea, Matthew C	Mar. 15, 1897
Leidy, Joseph	Apr. 30, 1891
*Lesquereux, Leo	Oct. 25, 1889
Longstreth, Miers F	Dec. 27, 1891
*Loomis, Elias	Aug. 16, 1889
Lovering, Joseph	Jan. 18, 1892
Lyman, Theodore	Sept. 10, 1897
*Mahan, D. H	Sept. 16, 1871
*Marsh, G. P	July 23, 1882
Marsh, O. C	Mar. 18, 1899
Mayer, Alfred M	July 13, 1897
*Meek, F. B	Dec. 21, 1877
*Meigs, M. C	Jan. 2, 1892
*Morgan, Lewis H	Dec. 14, 1881
Newberry, J. S	Dec. 7, 1892
*Newton, H. A	Aug. 1, 1896
Newton, John	May 1, 1895
*Norton, William A	Sept. 21, 1883
*Oliver, James E	Mar. 27, 1895
Peters, C. H. F	July 18, 1890
*Pourtales, L. F	July 19, 1880
Rodgers, John	May 5, 1882
Rogers, Robert E	Sept. 7, 1884
*Rogers, Wm. A	Mar. 1, 1898
*Rogers, William B	May 30, 1882
*Rutherford, Lewis M	May 30, 1892
*Saxton, Joseph	Oct. 26, 1873
*Silliman, Benj., Sr	Nov. 24, 1864
Silliman, Benj., Jr	Jan. 14, 1885
*Smith, J. Lawrence	Oct. 12, 1883
*Stimpson, William	May 26, 1873
*Strong, Theodore	Feb. 1, 1869
*Sullivant, W. S	Apr. 30, 1873
*Torrey, John	Mar. 10, 1873
*Totten, J. G	Apr. 22, 1864
*Trowbridge, William P	Aug. 12, 1892
Trumbull, James H	Aug. 5, 1897
*Tuckerman, Edward	Mar. 15, 1886
Walker, Francis A	Jan. 5, 1897
*Warren, G. K	Aug. 8, 1882
*Watson, James C	Nov. 23, 1880
*Watson, Sereno	Mar. 9, 1892
*Winlock, Joseph	June 11, 1875
*Woodward, J. J., U. S. A	Aug. 17, 1884
*Worthen, A. H	May 6, 1888
*Wyman, Jeffries	Sept. 4, 1874

FOREIGN ASSOCIATES.

Auwers, Arthur	*Berlin.*
Baeyer, Adolph (Ritter von)	*Munich.*
Berthelot, M. P. E	*Paris.*

*Biographical notices have been presented of those designated by an asterisk.

BERTRAND, J. L. F.	*Paris.*
GEGENBAUR, KARL	*Heidelberg.*
GILL, DAVID	*Cape Town.*
HOOKER, Sir J. D.	*Kew.*
KELVIN (Lord)	*Glasgow.*
KLEIN, FELIX	*Göttingen.*
KÖLLIKER, ALBERT VON	*Würzburg.*
LACAZE-DUTHIERS, HENRI DE	*Paris.*
LISTER (Lord)	*London.*
MOISSAN, HENRI	*Paris.*
POINCARÉ, HENRI	*Paris.*
RAYLEIGH (Lord)	*London.*
RICHTHOFEN, F. VON	*Berlin.*
STOKES, Sir GEORGE G	*Cambridge.*
STRASBURGER, EDOUARD	*Bonn.*
STRUVE, OTTO VON	*Karlsruhe.*
SUESS, EDOUARD	*Vienna.*
VIRCHOW, RUDOLPH VON	*Berlin.*
ZITTEL, KARL ALFRED (RITTER VON)	*Munich.*

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.
KARL ERNST VON BAER.
HENRY MILNE-EDWARDS.
MICHAEL FARADAY.
L. ELIE DE BEAUMONT.
SIR DAVID BREWSTER.
G. A. A. PLANA.
F. W. A. ARGELANDER.
FRIEDRICH WÖHLER.
J. B. DUMAS.
J. B. J. D. BOUSSINGAULT.
M. E. CHEVREUL.
MICHEL CHASLES.
SIR GEORGE B. AIRY.
J. C. ADAMS.
SIR RICHARD OWEN.
C. H. C. BURMEISTER.
ARTHUR CAYLEY.
T. H. HUXLEY.
HUGO GYLDÉN.
F. F. TISSERAND.
JULIUS VON SACHS.
SIR RODERICK I. MURCHISON.
VICTOR REGNAULT.
H. W. DOVE.
C. A. F. PETERS.
JUSTUS VON LIEBIG.
ALEXANDER BRAUN.
JOACHIM BARRANDE.
ADOLPHE WÜRTZ.
THEODORE VON OPPOLZER.
G. R. KIRCHOFF.
RUDOLPH CLAUSIUS.
JAMES P. JOULE.
CARLOS IBAÑEZ.
JEAN SERVAIS STAS.
ALPHONSE DE CANDOLLE.
A. W. HOFMANN.
BARON H. VON HELMHOLTZ.
K. F. W. LUDWIG.
LOUIS PASTEUR.
AUGUST KEKULÉ.
EMIL DU BOIS REYMOND.
J. J. SYLVESTER.
KARL WEIERSTRASS.
RUDOLPH LEUCKART.
C. F. RAMMELSBERG.
SOPHUS LIE.
ROBERT W. BUNSEN.

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REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1900.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

LETTER FROM THE VICE-PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES, SUBMITTING A REPORT OF THE OPERATIONS OF THE NATIONAL ACADEMY OF SCIENCES FOR THE PAST YEAR, 1900.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 3, 1901.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences for the past year.

Very respectfully,

ASAPH HALL,
Vice-President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations and hold the same in trust, to be applied by the said Academy in aid of scientific investigations and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 24, 1884.*

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

REPORT

OF

THE NATIONAL ACADEMY OF SCIENCES.

SESSIONS OF THE NATIONAL ACADEMY.

During the year 1900 the Academy held three sessions. The first was the regular annual session held at Washington April 17 to 19, inclusive. The second was a scientific session held at Providence November 13 and 14. The third, a special session held at Providence November 14 for the transaction of business.

ANNUAL MEETING.

The session was held in the Columbian University, the President, Mr. Wolcott Gibbs, presiding.

The following members were present during the session: Abbe, Agassiz, Allen, Barus, Beecher, Billings, Boss, Brewer, Brooks, Brush, Chandler (S. C.), Chittenden, Comstock (C. B.), Dall, Dana, Dutton, Elkin, Emmons, Farlow, Gibbs (W.), Gilbert, Gill, Hague, Hall, Hill (G. W.), Langley, Mitchell (S. W.), Morse, Powell, Putnam, Remsen, Rowland, Schott, Walcott, Welch, White, Wilson.

REPORTS.

The President reported that no business from Congress or from the Departments had required the attention of the Academy since its meeting in April, 1899.

THE BARNARD MEDAL.

The President stated that he had appointed as committee on the Barnard medal:

J. S. Billings, chairman.
H. P. Bowditch.
Simon Newcomb.
Henry A. Rowland.
O. N. Rood.
Charles L. Jackson.
Seth C. Chandler.

INTERNATIONAL SCIENTIFIC ASSOCIATION.

The President said that, in accordance with the resolution passed by the Academy at the meeting in November last, he had notified the Royal Academy of Sciences in Berlin that the National Academy approved of the plan of organization of the International Association of Academies, adopted by the congress at Wiesbaden, and accepted membership therein. The following delegates were afterwards appointed to attend the meeting of the International Association in Paris during the summer of 1900:

H. L. Abbot.
J. M. Crafts.
A. G. Bell.

The President said that, in accordance with another resolution, passed by the Academy in November, he had referred the communication of the International Congress of Physicists to the President of the American Physical Society, Prof. Henry A. Rowland.

REPORT OF HOME SECRETARY.

During the past year the President's report for 1899 and the fourth memoir of Volume VIII have been printed; 160 copies of the report have been distributed, and nearly 900 copies of the memoir, 400 of which were sent to the authors.

Biographical memoirs of W. A. Rogers and J. P. Cooke have also been printed, but have not yet been distributed. These biographical memoirs are stored away by the printers until a sufficient number accumulates to make a volume.

A large number of packages, containing publications of learned societies, etc., have been received and stored unopened in the Smithsonian Building, as in former years.

REPORT OF THE FOREIGN SECRETARY.

The foreign secretary stated that the fifth Watson medal which had been awarded had been given to him with instructions to hand it to the British Ambassador for transmission to Mr. David Gill, at the Cape of Good Hope.

REPORT OF THE TREASURER.

WASHINGTON, D. C., *April 17, 1900.*

THE PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 17, 1900.

Income.	General fund.	Bache fund.	Watson fund.	Draper fund.	Smith fund.	Gould fund.	Emmons and Gill trustees.
Balance brought forward:							
Cash	$614.92	$2,707.50	$3,723.19	$2,010.92	$319.07	$890.61	.....
Invested income	500.00	1,000.00	500.00	.....	1,496.57	.....	.....
Interest	18.26	2,022.02	940.72	341.26	259.65	940.00	.....
Members' tax	440.00	.....	.....	.....	.....	.....	.....
Appropriation returned	.....	46.97	.....	.....	.....	.....	.....
Emmons and Gill trustees	.....	.....	.....	.....	.....	.....	$245.00
Total	1,573.18	5,776.49	5,163.91	2,352.18	2,075.29	1,830.61	245.00
Disbursed	839.98	1,135.97	975.70	12.60	13.16	631.91	112.39
Balance:							
Cash	733.25	3,640.52	3,094.50	2,339.58	565.56	1,198.70	132.61
Invested	500.00	1,000.00	1,093.71	.....	1,496.57	.....	.....
Total accounted for	1,573.18	5,776.49	5,163.91	2,352.18	2,075.29	1,830.61	245.00

Outstanding obligation, C. L. Doolittle (Gould fund), $200.

CHAS. D. WALCOTT, *Treasurer.*

The report of the treasurer was referred to an auditing committee consisting of Messrs. Gill and Dall.

The committee appointed to examine the securities and papers found in the box of the National Academy of Sciences, safe deposit company, reported that they had examined the securities and papers, as described, and found them to correspond with these lists.

THEO. N. GILL, *Chairman.*
WM. H. DALL.

The committee appointed to examine the report of the treasurer respectfully report that they have performed this duty, and they hereby certify that the statements of expenditures, receipts, and balances correspond to the vouchers and accounts of the treasurer and are found correct.

THEO. N. GILL, *Chairman.*
WM. H. DALL.

RESIGNATION OF THE PRESIDENT.

Mr. Wolcott Gibbs read his resignation of the office of President of the Academy. This resignation was accepted with reluctance, to take effect at the close of the present session. The election of a President will be held at the next stated session, at Washington, in April, 1901.

REPORTS FROM TRUST FUNDS.

The Bache fund.

The President, as chairman of the trustees of this fund, reported the following appropriations since the meeting of the Academy in November, 1899:

1900.

Apr. 5. To Dr. H. C. Wood, for an investigation of the relation between the pulmonic and systemic circulation $300

Apr. 10. To Lewis Boss, for investigations on the standard stars..... 1,000

Apr. 11. To Asaph Hall, jr., for investigations on the constant of aberration and the variation of latitude..... 250

The Watson fund.

(No report.)

The Draper fund.

(No report.)

The Smith fund.

(No report.)

The Gibbs Fund.

To the National Academy of Sciences.

GENTLEMEN: I have the honor to report that the income of the Wolcott Gibbs fund for research in chemistry was awarded to Dr. Wolcott Gibbs for use in his investigations.

Very respectfully,

C. L. JACKSON, *Chairman.*

The Gould fund.

The directors of the Benjamin Apthorp Gould fund desire respectfully to report the following grants of appropriations from the income of this fund:

To Herman S. Davis, in aid of the new reduction of Piazzi's observations..... $500

To John A. Parkhurst, in aid of his investigations of variable stars..... 30

Respectfully submitted.

LEWIS BOSS,
S. C. CHANDLER,
ASAPH HALL,
Directors.

THE BARNARD MEDAL.

Dr. WOLCOTT GIBBS,

President National Academy of Sciences.

DEAR SIR: The committee appointed by you to select one or more names of persons who are best entitled to receive the Barnard medal from Columbia University respectfully report that, after careful consideration of the subject, the name of Prof. Wilhelm Conrad Röntgen is presented as being that of the person who has within the five years beginning July 17, 1894, made the discovery which is most worthy of this honor, under the terms of the will of President Barnard.

Professer Röntgen announced his discovery of what he called the X-rays, now commonly known as Röntgen rays, in December, 1895. These rays exhibit many peculiar properties, and have been applied to various practical uses, the most important of which thus far have been in surgery. They are at the present time one of the most interesting and important subjects of research in physical science, and the discovery may be properly termed an epoch-making one.

In this recommendation the committee are unanimous.

J. S. BILLINGS.
H. P. BOWDITCH.
S. C. CHANDLER.
H. A. ROWLAND.
O. N. ROOD.
C. L. JACKSON.
S. NEWCOMB.

List of recipients of medals awarded by the Academy.

THE DRAPER MEDAL.

Samuel P. Langley	1885
Edward C. Pickering	1887
Henry A. Rowland	1889
H. C. Vogel	1892
James E. Keeler	1899

THE WATSON MEDAL.

Benjamin A. Gould	1886
Edward Schönfeld	1888
Arthur Auwers	1890
Seth C. Chandler	1894
David Gill	1899

THE J. LAWRENCE SMITH MEDAL.

Hubert A. Newton	1888

THE BARNAND MEDAL.

Lord Rayleigh and Prof. William Ramsay	1895
Wilhelm Conrad Röntgen	1900

ELECTIONS.

Messrs. Billings, Bowditch, Brush, W. Gibbs, Hague, and Newcomb were elected members of the council.

Messrs. James E. Keeler, Henry F. Osborn, Samuel L. Penfield, and Franz Boas were elected members of the Academy.

LIST OF PAPERS PRESENTED AT THE APRIL SESSION.

Secondary Enrichment of Sulphides in Ore Deposits. S. F. Emmons.

On the Zoogeographical Relationships of Africa. Theodore Gill.

The Cruise of the United States Fish Commission Steamer *Albatross* in South Seas, August, 1899, to March, 1900. A. Agassiz.

West Indian Madreporarian Polyps. J. E. Duerden; introduced by W. K. Brooks.

Report of the Watson Trustees on the award of the Watson Medal to Mr. David Gill. Simon Newcomb.

The Anatomy of *Nautilus pompilius*. L. E. Griffin; introduced by W. K. Brooks.

On the Use of Electric Motors of the Shunt Type for Solving Linear Differential Equations of any Order with Variable Coefficients. Reginald A. Fessenden; introduced by Cleveland Abbe.

On the Prediction of the Physical Properties of the Pure Metals. Reginald A. Fessenden; introduced by Cleveland Abbe.

A Partial Explanation of Some of the Principal Ocean Tides. Rollin A. Harris; introduced by Cleveland Abbe.

A Human Bone from the Glacial Deposit at Trenton, N. J. F. W. Putnam.

The Academy then adjourned to meet in Providence November 13.

SCIENTIFIC SESSION.

[Held in Providence November 13 and 14, 1900.]

A scientific session for the reading of papers having been called by the council, the Academy met at Brown University, Providence, the Vice-President, Mr. Asaph Hall, presiding.

The following members were present during the session: Abbe, Barus, Billings, Bowditch, Brush, Crafts, Farlow, Gill, Hague, Hall, Hyatt, Mendenhall, Michelson, Minot, Morse, Packard, Penfield, Remsen, Richards, Verrill, Walcott.

The following titles of papers were presented:

I. Investigations of Light and Electricity with the Aid of a Battery of Twenty Thousand Cells. J. Trowbridge.

II. Progressive Evolution of Characters in the Young Stages of Cephalopods. Alpheus Hyatt.

III. Descriptive Method of Presenting the Phenomena of the Cycle of Evolution among Cephalopods. Alpheus Hyatt.

IV. The Porous Cup Voltameter. T. W. Richards.

V. An Account of the Study of Growing Crystals by Instantaneous Microphotography. T. W. Richards.

VI. Stereographic Projection and Some of its Possibilities from a Graphical Standpoint. S. L. Penfield.

VII. On the Development of the Pig. C. S. Minot.

VIII. Normal Plates Illustrating the Development of the Rabbit and the Dogfish. C. S. Minot.

IX. Note on the Energy of Recent Earthquakes. T. C. Mendenhall.

X. Spectrum of Sodium in a Magnetic Field. A. A. Michelson.

XI. A report of the Spectrum Work Carried on with the Aid of a Grant from the Bache Fund. H. A. Rowland.

XII. On the Explanation of Inertia and Gravitation by Means of Electrical Phenomena. H. A. Rowland.

XIII. Distribution of Philogeny of Limulus. A. S. Packard.

XIV. Male Preponderance (Androrhopy) in Lepidopterous Insects. A. S. Packard.

XV. The Synthesis and Reactions of Sodium Acetate Ester, and their Relation to a New Interpretation of Chemical Metathesis. A. Michael.

XVI. On the Genesis of Matter. A. Michael.

XVII. Demonstration of the Projection of One Grating by Another. C. Barus.

XVIII. Exhibition of Certain Novel Apparatus; A Wave Machine; An Expansion Lens; A Recording System of Two Degrees of Freedom; A Tube Showing Colored Cloudy Condensation. C. Barus.

XIX. On Stability of Vibration and on Vanishing Resonance. C. Barus.

XX. Hysteresis-like Phenomena in Torsional Magnetostriction and Their Relation to Viscosity. C. Barus.

XXI. Report on the Meeting of the Committee of the International Association of Academies. J. M. Crafts.

XXII. Progress in the Echelon Spectroscope. A. A. Michelson.

XXIII. Recent Observations of the Planet Eros. E. C. Pickering.

XXIV. Screens free from Relative Absorption. E. C. Pickering.

XXV. Folding and Faulting of Strata in Cordilleran Area. Charles D. Walcott.

BUSINESS MEETING OF THE ACADEMY.

[Providence, November 14, 1900.]

A business meeting of the Academy was called to consider the report of the Acting President to Congress and such other business as might be presented.

The Acting President read an outline of his report to Congress for the year 1900. The recommendation of the Council that the Acting President be authorized to include in his annual report to Congress the proceedings of the present meeting, as well as those of the meeting in Washington, April, 1900; and also any matters relating to Government business which may be submitted to the Academy prior to the presentation of his report, was approved.

REPORT OF J. M. CRAFTS,

Delegate of the Academy to the Meeting of the International Association of Academies.

I have not been able to obtain a report of the sittings of the committee representing the International Association of Academies, although it was understood that such a report would be promptly prepared, and I have written a month ago to M. Darboux to ask for a copy; but there were only two sittings of short duration, and little business was transacted, so that I can state to the Academy the principal features of the sessions.

It will be remembered that delegates from 9 academies met at Wiesbaden in October, 1899, upon the invitation of the Berlin Academy. The chief business at this meeting consisted in the establishment of a programme and the selection of 19 national academies which were invited to enter into an international association.

The Academy of Madrid has made no reply. Eighteen academies, sitting in the following capitals, gave in their adherence: Amsterdam, Berlin, Brussels, Budapest, Christiania, Copenhagen, Göttingen, Leipsic, London, Munich, Paris Academy of Sciences, Paris Academy of Inscriptions and Belles-Lettres, Paris Academy of Moral and Political Science, St. Petersburg, Rome, Stockholm, Vienna, Washington.

The letter of invitation had declared that other academies may be taken into the association by a vote of two-thirds of the academies which are associated.

The association comprises a literary and a scientific section, and each academy having these two sections may send two delegates to the meetings of the general committee. Twelve of the 18 are in this case; 4 have only a scientific section, and the 2 literary academies of Paris are only represented in their section.

It is expected that a general assembly will take place every three years, each academy sending any number of delegates, but having only one vote.

A meeting of an international committee will be held each year, with 16 scientific and 14 literary delegates. Rules of proceedings were adopted at Wiesbaden and accepted by the 18 academies which have joined the association. These rules can only be modified or extended by a two-thirds vote.

A very brief clause describes the objects of the association as being "to prepare and forward scientific work of general interest proposed by the academies and to facilitate international scientific relations."

It was under this constitution that a first meeting of the general committee was held in Paris, July 31, 1900, at the palace of the institute, M. Darboux, perpetual secretary of the Academy of Sciences, presiding under the rules, and Professor Diels,

perpetual secretary of the Berlin Academy in the section of history and philosophy, was chosen vice-president and presided over the literary section. About twenty delegates were present.

It was understood that a general meeting would be held after that of the committee, and General Abbot, A. Graham Bell, and myself were appointed delegates. M. Darboux seems to have been informed that I was the delegate to the committee, our Academy having the right to send only one to its meeting. Unfortunately, as I think, the general meeting at which several delegates may take part was put off till April 16, 1901, in consequence of the desire expressed by a majority of the delegates to consult with their academies before that meeting.

I do not remember that questions of policy were brought up making such consultation necessary, and I should be interested to know whether communications upon such subjects have been received by the secretary.

The chief business done was the passage of rules that—

First. Each academy should pay the traveling expenses of its delegate, but without compulsion, which was interpreted only to mean that the international association should not pay them.

Second. The small expenses of printing and correspondence were to be paid by the academy (*Vorort*) which held the meeting.

Third. Each academy will print 300 copies of projects which it may wish to lay before the association; 100 to be sent to the academy under the auspices of which the meeting is held (Vorort).

Fourth. Each academy will subscribe to the committee annually a sum not exceeding $40.

The committee received a letter from a Belgian gentleman, M. Samson, asking if the association had the rights *persona juris* to receive donations. He was informed that a donation might be placed in the hands of any national academy for the use of the association.

Three projects of international scientific interest were presented and favorably received.

A proposal to facilitate the circulation of manuscripts and rare works.

A resolution in favor of the measurement of a long arc of a meridian in the southern hemisphere, which is, I believe, under consideration by the geodetic congress.

A proposal to express approval of the commission named at Cambridge, England, in August, 1898, to provide a better control of the physiological enregistering apparatus; also, to nominate additional members.

If the Academy will permit me to add my personal impressions to this brief report of business, I will say that by far the most interesting incident was the appearance before the committee of M. Marey to explain the needs of further control of physiological instruments. He gave a masterly exposition of the present conditions and the utility of the intervention of an international committee. It is to be supposed that the consideration of such subjects will in future be the chief duty of the international association.

In many cases subjects of general interest will be brought before the public with the authority of the united academies; in other cases some national academies will be selected to make representations to their respective governments in favor of some measure like a general geodetic survey.

Without doubt the most convenient rules of procedure will be best established by the form that the business gradually takes in the meetings of delegates; but it is true that they are sent as representatives of their academies, and many questions may arise where they would wish to receive instructions from the academies. For this reason I think it is to be regretted that a general assembly was not held this summer, giving opportunities to a large number of delegates to express opinions, to formulate rules of procedure, and to consult with the academies previous to their adoption in a subsequent meeting of the international association.

APPENDIX A.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895; April 20, 1899.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may,

subject or subjects in which the person nominated is stated to be eminent; and in order that his name may be brought before the Academy for election he must receive the votes of a majority of the members of the committee or committees to which his name has been referred.

Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot the members present may proceed to elect new members in the following manner: At each ballot each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members, to be appointed for that purpose by the president and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the Academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the Academy and his name shall be dropped from the roll.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States, or, with

7. Other business.

8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session; but no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date, in the records of the Academy, from the date of their presentation to the Academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred at the meeting at which they are read to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XIII. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XIV. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XV. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVI. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Govern-

ment, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XVII. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XVIII. At least sixty days before the election the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XIX. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XX. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXI. Any rule of the Academy may be amended, suspended, or repealed, on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is ex officio a member of all government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1901.

	Expiration of term.
——, ——	——
HALL, ASAPH, *Vice-President*	April, 1903.
AGASSIZ, A., *Foreign Secretary*	April, 1901.
REMSEN, IRA, *Home Secretary*	April, 1903.
WALCOTT, CHARLES D., *Treasurer*	April, 1904.

ADDITIONAL MEMBERS OF COUNCIL, 1901.

BILLINGS, J. S.
BOWDITCH, H. P.
BRUSH, G. J.
GIBBS, W.
HAGUE, A.
NEWCOMB, S.

COMMITTEES OF THE ACADEMY.

On nominations of new members.

1. Mathematics and Astronomy.
   - ABBE, C.
   - BOSS, L.
   - CHANDLER, S. C.
   - COMSTOCK, G. C.
   - DAVIDSON, G.
   - ELKIN, W. L.
   - HALL, A.
   - HILL, G. W.
   - HOLDEN, E. S.
   - NEWCOMB, S.
   - PEIRCE, C. S.
   - PICKERING, E. C.
   - WOODWARD, R. S.
   - YOUNG, C. A.
2. Physics and Engineering.
   - ABBE, C.
   - ABBOT, H. L.
   - BARKER, G. F.
   - BARUS, C.
   - BELL, A. G.
   - COMSTOCK, C. B.
   - GIBBS, J. W.
   - HASTINGS, C. S.
   - LANGLEY, S. P.
   - MENDENHALL, T. C.
   - MICHELSON, A. A.
   - MITCHELL, H.
   - MORLEY, E. W.
   - MORTON, H.
   - PICKERING, E. C.
2. Physics and Engineering—Continued.
   - ROOD, O. N.
   - ROWLAND, H. A.
   - SCHOTT, C. A.
   - SELLERS, W.
   - TROWBRIDGE, J.
   - WOODWARD, R. S.
   - WRIGHT, A. W.
3. Chemistry.
   - BARKER, G. F.
   - BRUSH, G. J.
   - CHANDLER, C. F.
   - CHITTENDEN, R. H.
   - CRAFTS, J. M.
   - DANA, E. S.
   - GIBBS, W.
   - GOOCH, F. A.
   - HILGARD, E. W.
   - HILL, H. B.
   - JACKSON, C. L.
   - JOHNSON, S. W.
   - MICHAEL, A.
   - MORLEY, E. W.
   - PENFIELD, S. L.
   - REMSEN, I.
   - RICHARDS, T. W.
   - SMITH, E. F.
4. Geology and Paleontology.
   - BEECHER, C. E.
   - DALL, W. H.
   - DUTTON, C. E.

On nominations of new members—Continued.

4. Geology and Paleontology—Cont'd.
   - EMMONS, S. F.
   - GILBERT, G. K.
   - HAGUE, A.
   - KING, C.
   - LE CONTE, J.
   - LESLIE, J. P.
   - OSBORN, H. F.
   - PUMPELLY, R.
   - WALCOTT, C. D.
   - WHITE, C. A.

5. Biology.
   - AGASSIZ, A.
   - ALLEN, J. A.
   - BOWDITCH, H. P.
   - BREWER, W. H.
   - BROOKS, W. K.
   - CHITTENDEN, R. H.
   - DALL, W. H.
   - FARLOW, W. G.
   - GILL, T. N.
   - GOODALE, G. L.
   - HYATT, A.
   - MINOT, C. S.
   - MORSE, E. S.

5. Biology—Continued.
   - OSBORN, H. F.
   - PACKARD, A. S.
   - PUTNAM, F. W.
   - SARGENT, C. S.
   - SCUDDER, S. H.
   - SMITH, S. I.
   - VERRILL, A. E.
   - WALCOTT, C. D.
   - WELCH, W. H.
   - WHITE, C. A.
   - WHITMAN, C. O.
   - WILSON, E. B.
   - WOOD, H. C.

6. Anthropology.
   - BILLINGS, J. S.
   - BOAS, F.
   - MAYO-SMITH, R.
   - MINOT, C. S.
   - MITCHELL, S. W.
   - MORSE, E. S.
   - POWELL, J. W.
   - PUTNAM, F. W.
   - WELCH, W. H.

On Weights, Measures, and Coinage.

MENDENHALL, T. C. — NEWCOMB, S.
MICHELSON, A. A. — PEIRCE, C. S.
YOUNG, C. A.

On the Election of Foreign Associates.

AGASSIZ, A., *Chairman.* — MITCHELL, S. W.
HALL, A. — NEWCOMB, S.

On Publications of the Academy.

GILL, T. N.

TRUST FUNDS.

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GIBBS, WOLCOTT. — CHANDLER, S. C.
SCUDDER, S. H.

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BOWDITCH, H. P. ROOD, O. N.
CHANDLER, S. C. JACKSON, C. L.

NEWCOMB, S.

The Wolcott Gibbs Fund.

JACKSON, C. L. REMSEN, IRA.

DROWN, T. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY 1, 1901.

		Date of election.
ABBE, CLEVELAND	*2017 I st NW., Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*Army Building, New York City.*	1872
AGASSIZ, ALEXANDER	*Cambridge, Mass.*	1866
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	*3909 Locust st., Philadelphia, Pa.*	1876
BARUS, CARL	*Providence, R. I.*	1892
BEECHER, CHARLES E	*New Haven, Conn.*	1899
BELL, A. GRAHAM	*1331 Connecticut ave., Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*32 E. Thirty-first st., New York City.*	1883
BOAS, FRANZ	*123 W. Eighty-second st., New York City.*	1900
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*418 Orange st., New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BRUSH, GEORGE J	*14 Trumbull st., New Haven, Conn.*	1868
CHANDLER, CHARLES F	*New York City.*	1874
CHANDLER, SETH C	*16 Craigie st., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*34 W. Twenty-fifth st., New York City.*	1884
COMSTOCK, GEORGE C	*Washburn Observatory, Madison, Wis.*	1899
CRAFTS, JAMES M	*59 Marlboro st., Boston, Mass.*	1872
DALL, WILLIAM H	*Washington, D. C.*	1897
DANA, EDWARD S	*New Haven, Conn.*	1884
DAVIDSON, GEORGE	*2221 Washington st., San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Ordnance Office, War Dep't, Washington, D. C.*	1884
ELKIN, WILLIAM L	*New Haven, Conn.*	1895
EMMONS, SAMUEL F	*Washington, D. C.*	1892
FARLOW, W. G	*Cambridge, Mass.*	1879
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOOCH, FRANK A	*New Haven, Conn.*	1897
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885

		Date of election.
HALL, ASAPH	*12 Kirkland place, Cambridge, Mass.*	1875
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*West Nyack, N. Y.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*Century Club, New York City.*	1885
HYATT, ALPHEUS	*234 Berkeley st., Boston, Mass.*	1875
JACKSON, CHARLES L	*6 Boylston Hall, Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*54 Trumbull st., New Haven, Conn.*	1866
KING, CLARENCE	*Century Club, New York City.*	1876
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LE CONTE, JOSEPH	*Berkeley, Cal.*	1875
LESLEY, J. PETER	*711 Walnut st., Philadelphia, Pa.*	——
MAYO-SMITH, RICHMOND	*305 W. Seventy-seventh st., New York City.*	1890
MENDENHALL, THOMAS C	*Worcester, Mass.*	1887
MICHAEL, ARTHUR	*Tufts College, Mass.*	1889
MICHELSON, ALBERT A	*Chicago, Ill.*	1888
MINOT, CHARLES S	*Boston, Mass.*	1897
MITCHELL, HENRY	*Nantucket, Mass.*	1885
MITCHELL, S. WEIR	*1524 Walnut st., Philadelphia, Pa.*	1865
MORLEY, EDWARD W	*Adelbert College, Cleveland, Ohio.*	1897
MORSE, EDWARD S	*P. O. Box 268, Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWCOMB, SIMON, U. S. N	*1620 P st. NW., Washington, D. C.*	1869
OSBORN, H. F	*New York City.*	1900
PACKARD, A. S	*Providence, R. I.*	1872
PEIRCE, CHARLES S	*Milford, Pa.*	1876
PENFIELD, S. L	*New Haven, Conn.*	1900
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PUMPELLY, RAPHAEL	*Gibbs ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
RICHARDS, THEODORE W	*Cambridge, Mass.*	1899
ROOD, OGDEN N	*New York City.*	1865
ROWLAND, HENRY A	*Johns Hopkins University, Baltimore, Md.*	1881
SARGENT, CHARLES S	*Jamaica Plain, Mass.*	1895
SCHOTT, CHARLES A	*212 First st. SE., Washington, D. C.*	1872
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	*1600 Hamilton st., Philadelphia, Pa.*	1873
SMITH, EDGAR F	*Philadelphia, Pa.*	1899
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
VERRILL, A. E	*New Haven, Conn.*	1872
WALCOTT, CHARLES D	*Washington, D. C.*	1896
WELCH, WILLIAM H	*935 St. Paul st., Baltimore, Md.*	1895
WHITE, CHARLES A	*330 T st. NW., Washington, D. C.*	1889
WHITMAN, CHARLES O	*University of Chicago, Chicago, Ill.*	1895
WILSON, EDMUND B	*Columbia University, New York City.*	1899
WOOD, HORATIO C	*1925 Chestnut st., Philadelphia, Pa.*	1879
WOODWARD, ROBERT S	*Columbia University, New York City.*	1896
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

DECEASED MEMBERS.

	Date of death.
*Agassiz, Louis	Dec. 14, 1873
*Alexander, J. H	Mar. 2, 1867
*Alexander, Stephen	June 25, 1883
*Bache, Alexander Dallas	Feb. 14, 1867
*Baird, Spencer F	Aug. 19, 1887
Barnard, F. A. P	Apr. 27, 1889
Barnard, J. G	May 14, 1882
Bartlett, W. H. C	Feb. 11, 1893
*Brown-Sequard, Charles E	Apr. 2, 1894
*Casey, Thomas L., U. S. A	Mar. 25, 1896
*Caswell, Alexis	Jan. 8, 1887
*Chauvenet, William	Dec. 13, 1870
*Clarke, Henry James	July 1, 1873
*Coffin, James H	Jan. 6, 1873
*Coffin, J. H. C	Jan. 8, 1890
*Cook, George H	Sept. 22, 1889
*Cooke, Josiah P	Sept. 3, 1894
*Cope, Edward D	Apr. 12, 1897
Coues, Elliott	Dec. 25, 1899
Dalton, J. C	Feb. 2, 1889
Dana, James D	Apr. 14, 1895
*Davis, Charles H	Feb. 18, 1877
*Draper, Henry	Nov. 20, 1882
*Draper, John W	Jan. 4, 1882
*Eads, James B	Mar. 8, 1887
*Engelman, George	Feb. 4, 1884
*Ferrel, William	Sept. 18, 1891
*Frazer, John Fries	Oct. 12, 1872
*Gabb, William M	May 30, 1878
Genth, F. A	Feb. 2, 1893
*Gilliss, James Melville	Feb. 9, 1865
*Goode, G. Brown	Sept. 6, 1896
*Gould, Augustus A	Sept. 15, 1866
Gould, Benjamin A	Nov. 27, 1896
*Gray, Asa	Jan. 30, 1888
*Guyot, Arnold	Feb. 8, 1884
*Hadley, James	Aug. 1, 1864
*Haldeman, S. S	Sept. 20, 1880
Hall, James	Aug. 8, 1898
*Hayden, F. V	Dec. 22, 1887
*Henry, Joseph	May 13, 1878
*Hilgard, Julius E	May 8, 1891
*Hitchcock, Edward	Feb. 27, 1864
*Holbrook, J. E	Sept. 8, 1871
*Hubbard, J. S	Aug. 16, 1863
*Humphries, A. A	Nov. 28, 1883
Hunt, T. Sterry	Feb. 12, 1892
Keeler, J. E	Aug. 12, 1900
*Kirkland, Jared P	Dec. 10, 1877

* Biographical notices have been presented of those designated by an asterisk.

	Date of death.
* Lane, J. Homer	May 3, 1880
* Le Conte, John	Apr. 29, 1891
* Le Conte, John L	Nov. 15, 1883
Lea, Matthew C	Mar. 15, 1897
Leidy, Joseph	Apr. 30, 1891
* Lesquereux, Leo	Oct. 25, 1889
Longstreth, Miers F	Dec. 27, 1891
* Loomis, Elias	Aug. 16, 1889
Lovering, Joseph	Jan. 18, 1892
Lyman, Theodore	Sept. 10, 1897
* Mahan, D. H	Sept. 16, 1871
* Marsh, G. P	July 23, 1882
Marsh, O. C	Mar. 18, 1899
Mayer, Alfred M	July 13, 1897
* Meek, F. B	Dec. 21, 1877
* Meigs, M. C	Jan. 2, 1892
* Morgan, Lewis H	Dec. 14, 1881
Newberry, J. S	Dec. 7, 1892
* Newton, H. A	Aug. 1, 1896
Newton, John	May 1, 1895
* Norton, William A	Sept. 21, 1883
* Oliver, James E	Mar. 27, 1895
Peters, C. H. F	July 18, 1890
* Pourtales, L. F	July 19, 1880
Rodgers, John	May 5, 1882
Rogers, Fairman	Aug. 23, 1900
Rogers, Robert E	Sept. 7, 1884
* Rogers, Wm. A	Mar. 1, 1898
* Rogers, William B	May 30, 1882
* Rutherford, Lewis M	May 30, 1892
* Saxton, Joseph	Oct. 26, 1873
* Silliman, Benj., Sr	Nov. 24, 1864
Silliman, Benj., Jr	Jan. 14, 1885
* Smith, J. Lawrence	Oct. 12, 1883
* Stimpson, William	May 26, 1873
* Strong, Theodore	Feb. 1, 1869
* Sullivant, W. S	Apr. 30, 1873
* Torrey, John	Mar. 10, 1873
* Totten, J. G	Apr. 22, 1864
* Trowbridge, William P	Aug. 12, 1892
Trumbull, James H	Aug. 5, 1897
* Tuckerman, Edward	Mar. 15, 1886
Walker, Francis A	Jan. 5, 1897
* Warren, G. K	Aug. 8, 1882
* Watson, James C	Nov. 23, 1880
* Watson, Sereno	Mar. 9, 1892
* Winlock, Joseph	June 11, 1875
* Woodward, J. J., U. S. A	Aug. 17, 1884
* Worthen, A. H	May 6, 1888
* Wyman, Jeffries	Sept. 4, 1874

* Biographical notices have been presented of those designated by an asterisk.

FOREIGN ASSOCIATES.

AUWERS, ARTHUR	*Berlin.*
BAEYER, ADOLPH (RITTER VON)	*Munich.*
BERTHELOT, M. P. E	*Paris.*
GEGENBAUR, KARL	*Heidelberg.*
GILL, DAVID	*Cape Town.*
HOOKER, Sir J. D	*Kew.*
KELVIN (Lord)	*Glasgow.*
KLEIN, FELIX	*Göttingen.*
KÖLLIKER, ALBERT VON	*Würzburg.*
LACAZE-DUTHIERS, HENRI DE	*Paris.*
LISTER (Lord)	*London.*
MOISSAN, HENRI	*Paris.*
POINCARÉ, HENRI	*Paris.*
RAYLEIGH (Lord)	*London.*
RICHTHOFEN, F. VON	*Berlin.*
STOKES, Sir GEORGE G	*Cambridge.*
STRASBURGER, EDOUARD	*Bonn.*
STRUVE, OTTO VON	*Karlsruhe.*
SUESS, EDOUARD	*Vienna.*
VIRCHOW, RUDOLPH VON	*Berlin.*
ZITTEL, KARL ALFRED (RITTER VON)	*Munich.*

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.
KARL ERNST VON BAER.
HENRY MILNE-EDWARDS.
MICHAEL FARADAY.
L. ELIE DE BEAUMONT.
SIR DAVID BREWSTER.
G. A. A. PLANA.
F. W. A. ARGELANDER.
FRIEDRICH WÖHLER.
J. B. DUMAS.
J. B. J. D. BOUSSINGAULT.
M. E. CHEVREUL.
MICHEL CHASLES.
SIR GEORGE B. AIRY.
J. C. ADAMS.
SIR RICHARD OWEN.
C. H. C. BURMEISTER.
ARTHUR CAYLEY.
T. H. HUXLEY.
HUGO GYLDÉN.
F. F. TISSERAND.
JULIUS VON SACHS.
SIR RODERICK I. MURCHISON.
VICTOR REGNAULT.
H. W. DOVE.
C. A. F. PETERS.
JUSTUS VON LIEBIG.
ALEXANDER BRAUN.
JOACHIM BARRANDE.
ADOLPHE WÜRTZ.
THEODORE VON OPPOLZER.
G. R. KIRCHOFF.
RUDOLPH CLAUSIUS.
JAMES P. JOULE.
CARLOS IBAÑEZ.
JEAN SERVAIS STAS.
ALPHONSE DE CANDOLLE.
A. W. HOFMANN.
BARON H. VON HELMHOLTZ.
K. F. W. LUDWIG.
LOUIS PASTEUR.
AUGUST KEKULÉ.
EMIL DU BOIS REYMOND.
J. J. SYLVESTER.
KARL WEIERSTRASS.
RUDOLPH LEUCKART.
C. F. RAMMELSBERG.
SOPHUS LIE.
ROBERT W. BUNSEN.
J. L. F. BERTRAND.

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O

REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1901.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1902.

LETTER FROM THE PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES SUBMITTING A REPORT OF THE OPERATIONS OF THE NATIONAL ACADEMY OF SCIENCES FOR THE PAST YEAR, 1901.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., January 10, 1902.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences for the past year.

Very respectfully,

A. AGASSIZ,
President of the National Academy of Sciences.

The PRESIDENT OF THE SENATE.

ACT OF INCORPORATION.

AN ACT to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Pierce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted*, That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and

regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AN ACT to amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said Academy as provided in said act.

Approved, July 14, 1870.

DEPARTMENT OF STATE, *June 10, 1882.*

True copies.

SEVELLON A. BROWN,
Chief Clerk.

AN ACT to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations and hold the same in trust, to be applied by the said Academy in aid of scientific investigations and according to the will of the donors.

Approved, June 20, 1884.

DEPARTMENT OF STATE, *June 24, 1884.*

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES.

SESSIONS OF THE NATIONAL ACADEMY.

During the year 1901 the Academy held three sessions: The first, the regular annual session, held at Washington April 16 to 18, inclusive; the second, a scientific session, held at Philadelphia November 12 to 14; the third, a special session, held at Philadelphia November 13 and 14, for the transaction of business.

ANNUAL MEETING.

The session was held at the U. S. National Museum, Washington, April 16, 17, and 18, the acting president, Mr. Asaph Hall, presiding.

The following members were present during the session: Messrs. Abbe, Abbot, Agassiz, Allen, Barus, Beecher, Bell, Billings, Boas, Boss, Bowditch, Brewer, Brooks, Brush, Chandler (S. C.), Chittenden, Dall, Emmons, Farlow, Gilbert, Gill, Hague, Hall, Hill (G. W.), Hyatt, King, Langley, Mendenhall, Michelson, Minot, Morley, Morse, Newcomb, Osborn, Penfield, Powell, Putnam, Remsen, Walcott, Welch, Wilson, and Woodward.

REPORTS.

The acting president made the following report:

Since the meeting of the Academy in November the following appointments have been made:

Mr. E. C. Pickering was appointed chairman of the trustees of the Henry Draper fund in place of Mr. G. F. Barker, resigned, and Mr. A. A. Michelson, a trustee of this fund, in place of Mr. C. A. Young, resigned.

Mr. E. W. Morley was appointed a member of the board of trustees of the J. Lawrence Smith fund in place of Mr. A. Hall, resigned.

Some difficulty was found in the appointment of a delegate to attend the meeting of the International Association of Academies to be held in Paris, April 16. Mr. George L. Goodale was appointed a delegate to attend the meeting if his health would permit.

Messrs. William G. Farlow and Theodore N. Gill were appointed delegates to attend the celebration of the four hundred and fiftieth anniversary of the foundation of the University of Glasgow on June 15, 1901.

The Academy has had no Government business to transact during the past year.

The home secretary reported as follows:

During the past year the report of the acting president for 1900 has been printed and distributed to members of the Academy and a few libraries in this country.

The fifth memoir of Volume VIII has been printed.

The Treasurer presented his report for the year, as follows:

REPORT OF THE TREASURER.

WASHINGTON, D. C., *April 16, 1901.*

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 16, 1901.

Income.	General fund.	Bache fund.	Watson fund.	Draper fund.	Smith fund.	Gould fund.	Emmons and Gill trustees.
Balance brought forward:							
Cash	$733.25	$3,640.52	$3,094.50	$2,339.58	$565.56	$1,198.70	$132.61
Invested income	500.00	1,000.00	1,093.71	.....	1,496.57	.....	.....
Interest	35.38	2,126.32	1,015.64	334.41	372.36	965.00	.....
Members' tax	425.00	.....	.....	.....	.....	.....	.....
Appropriation returned	.....	150.00	.....	.....	.....	.....	.....
Subscription to building fund	100.00	.....	.....	.....	.....	.....	.....
Emmons and Gill trustees	.....	.....	.....	.....	.....	.....	255.00
Total	1,793.63	6,916.84	5,203.85	2,673.99	2,434.49	2,163.70	387.61
Disbursed	282.51	2,750.58	423.84	1,012.60	768.16	1,011.91	47.13
Balance:							
Cash	1,011.12	1,166.26	1,786.30	1,660.39	174.76	1,151.79	340.48
Invested	500.00	3,000.00	2,993.71	.....	1,496.57	.....	.....
Total accounted for	1,793.63	6,916.84	5,203.85	2,673.99	2,434.49	2,163.70	387.61

Outstanding obligations, Lewis Boss (Bache fund), $1,000.

Very respectfully,

CHAS. D. WALCOTT, *Treasurer.*

The treasurer's report was referred to an auditing committee consisting of Messrs. Abbot, Minot, and Penfield, who, after due examination, reported as follows:

APRIL 16, 1901.

The committee appointed to examine the report of the treasurer *respectfully* report that they have performed this duty, and they hereby

certify that the statements of expenditures, receipts, and balances correspond to the vouchers and accounts of the treasurer and are found correct.

HENRY L. ABBOT.
CHARLES S. MINOT.
SAMUEL L. PENFIELD.

The committee consisting of Messrs. Schott, Emmons, and Dall, appointed to examine the securities and papers found in the box of the National Academy of Sciences at the American Security and Trust Company's building, reported that they had examined the securities and papers, as described, and found them to correspond with the list furnished by the treasurer.

THE DRAPER MEDAL.

The home secretary read a report from the committee on the Henry Draper fund recommending the award of the Henry Draper medal to Sir William Huggins for his investigations in astronomical physics.

CAMBRIDGE, MASS., *April 3, 1901.*

DEAR SIR: The Henry Draper committee met in New York on January 29, 1901, and voted unanimously to recommend to the Academy that the Henry Draper medal be awarded to Sir William Huggins for his investigations in astronomical physics. A statement of the reasons for this recommendation is enclosed herewith. The accumulated income of the fund on April 17, 1900, amounted to $2,339.58.

The deed of gift of Mrs. Draper provides that the accumulated income shall be used "in aid of investigation and work in astronomical physics to be made and carried on by a citizen or citizens of the United States of America." Accordingly, it was voted to appropriate the sum of $500 to Prof. W. W. Campbell for the construction of a one-prism spectograph for use with the 36-inch reflecting telescope now building for the Lick Observatory. It was also voted that an appropriation of $500 be made to Prof. George E. Hale, to be applied toward the construction of a horizontal coelostal reflecting telescope of 24 inches aperture and 200 feet focal length, for the Yerkes Observatory.

In order to carry out the terms of the deed of gift, it is proposed to make further appropriations from the income as suitable objects present themselves.

Respectfully submitted.

EDWARD C. PICKERING, *Chairman.*
A. A. MICHELSON.
SIMON NEWCOMB.
ARTHUR W. WRIGHT.
JOHN TROWBRIDGE.

Prof. ASAPH HALL,
Acting President, National Academy of Sciences.

INVESTIGATIONS IN ASTRONOMICAL PHYSICS BY SIR WILLIAM HUGGINS.

It is not an easy matter to concentrate into a few pages the results attained by an active worker during a period of nearly half a century. Fortunately, in the present case, this labor has been greatly simplified by the recent publication, by Sir William and Lady Huggins, of an Atlas of Representative Spectra from wave length 4,870 to 3,300, together with a discussion of the evolutional order of the stars, and the interpretation of their spectra, preceded by a short history of the Observatory and its work. This monumental volume not only furnishes a statement of the various publications of the authors, but exhibits the relation of the various investigations undertaken much better than could readily be done by another. From this it appears that the work began in 1856 with a 5-inch Dolland equatorial, which was replaced two years later by an excellent 8-inch Clark telescope. In 1870 this was again replaced by a 15-inch achromatic and an 18-inch reflector. In 1858 Sir William, then Mr. Huggins, undertook with Dr. Miller the visual study of stellar spectra. This work was continued until 1864, and the results were communicated to the Royal Society. Soon after this, on August 29, 1864, Sir William made one of the great discoveries in astrophysics. He found that the spectrum of the planetary nebula in Draco, N. G. C. 6543, had a monochromatic spectrum.

It has heretofore been supposed that all nebulæ might consist of distant stars and could be resolved into their components by a telescope of sufficient power. This theory was at once disposed of, and it appeared that of 60 of the brighter nebulæ and clusters about one-third were of this gaseous character. In 1866 the observations of the new star in Corona gave the first clew to the cause of these remarkable objects. In 1868 Sir William was able to announce the first step in an investigation which in recent years has become one of the most important in astrophysics. The hydrogen lines in the brightest stars showed a slight displacement, from which the motion of these bodies in the line of sight may be determined. The accurate measurement of this quantity is now occupying a large part of the time of the greatest telescopes in the world. It is leading to unexpected results, which throw important light on the formation of the universe. The fact that these displacements are wholly independent of the distance of the source of light gives an opportunity to study problems for which ordinary visual methods fail entirely. About this time, also, a study of comets showed that their spectra closely resembled that of olefiant gas. A proposal of great scientific importance was a method of observing the solar protuberances in the uneclipsed sun. This method was devised independently by Mr. Lockyer. It is now claimed that these remarkable phenomena can be better seen any

clear day at a fixed observatory than with portable instruments during a total solar eclipse. In 1876 the study of the spectra of the stars by means of photography, which had been attempted without attaining satisfactory results in 1863, was undertaken. Among the results published four years later, one of the most important was the discovery of the wonderful series of lines due to hydrogen. Similar series of lines are now found to exist in the spectra of many other terrestrial elements, and form the basis of the spectroscopic relation of these substances with one another.

During the last quarter of a century Sir William and Lady Huggins have worked together in developing this most powerful method of research. Applying it to one object after another, a theory of the universe has been evolved, which is described in full in the work mentioned above. It is probable that this method must, in general, be followed in all attempts to study the chemical relation of stars to one another.

We thus see that Sir William Huggins's activity has extended over nearly half a century. During this time discoveries of the greatest importance have been made, on which advances in astrophysics largely depend. Besides this, laborious investigations have been undertaken, extending over many years, by which the methods discovered have been developed and applied. For this remarkable record of scientific activity and perseverance the undersigned recommend the award by the Academy of the Henry Draper medal to Sir William Huggins.

Respectfully submitted.

EDWARD C. PICKERING, *Chairman.*
A. A. MICHELSON.
S. NEWCOMB.
ARTHUR W. WRIGHT.
JOHN TROWBRIDGE.

Later the following letter was received from Sir William Huggins:

90, UPPER TULSE HILL, S. W., *April 16, 1901.*

DEAR SIR: I have the honor to acknowledge your letter of the 2d instant, informing me that the National Academy of Sciences have awarded to me the Henry Draper medal.

I beg, through you, to express to the Academy my high appreciation of this distinguished honor, and the further gratification it affords me to know that the award was unanimous.

I am, sir, yours faithfully,

WILLIAM HUGGINS.

To Professor REMSEN, etc.

REPORTS FROM TRUST FUNDS.

STATEMENT OF THE BOARD OF DIRECTORS OF THE BACHE FUND FOR THE ACADEMY YEAR 1900–1901.

The board of directors of the Bache fund make the following statement, as a matter of courtesy to the Academy, of the appropriations made by them since the last stated meeting of the Academy, April, 1900:

1900.

Apr. 5. To Dr. H. C. Wood, for investigation of the relations between the pulmonary and systemic circulations $300
(Of this appropriation $150 was unused and returned to the fund.)

Apr. 10. To Prof. Lewis Boss, for investigation of standard stars 1,000

Apr. 11. To Prof. Asaph Hall, jr., for investigation of aberration and variation of latitude 250

The above appropriations have been already reported at the November meeting of the Academy.

1900.

Apr. 28. To Prof. A. S. Packard, for continuation of investigation of bombycine moths, for drawings $300

Oct. 15. To Dr. E. C. Franklin, for the investigation of solutions of various substances in substituted ammonias 150

1901.

Jan. 8. To Dr. S. Weir Mitchell and Simon Flexner, for investigation of snake venom 600

Mar. 5. To Prof. Lewis Boss, for continuation of investigation of standard stars 1,000

Mar. 26. To Prof. Alpheus Hyatt, for measurement of the Achatinellidæ of the Hawaiian Islands 600

Mar. 28. To Prof. A. S. Packard, to complete the drawings for Part II of work on bombycine moths 300

At the beginning of the current year the board authorized the treasurer to transfer the sum of $2,000 to the invested income account from the cash income on hand.

Respectfully submitted.

WOLCOTT GIBBS.
SETH C. CHANDLER.
SAM. H. SCUDDER.

REPORT OF THE BOARD OF DIRECTORS OF THE BENJAMIN APTHORP GOULD FUND FOR THE YEAR 1900–1901.

The directors of the Benjamin Apthorp Gould fund respectfully submit the following report:

The following appropriations have been made since the last stated meeting of the Academy, April, 1900:

1900.

Apr. 18. To Mr. John A. Parkhurst, for observations of variable stars, to be expended for charts $30

Apr. 18. To Dr. Herman S. Davis, for new reduction of Piazzi's observations, to be expended for computer 500

Dec. 15. To Mr. Paul S. Yendell, for observations of variable stars, to be expended for photometric apparatus and construction of dome ... 225

Feb. 1. To Prof. Simon Newcomb, investigation on the planes of the galaxy and the bright stars 25

In addition to the above the sum of $500 has been appropriated for the purpose of bringing up the arrears of cometary research, and offered to American astronomers for the compution of definitive orbits of certain specified comets, to be distributed among the computers taking part in the work, the relative apportionment to be hereafter determined by the board.

In accordance with the vote of the Academy, April 19, 1899, the directors have prepared a report of progress of all the work which they have encouraged, so far as such a report is practicable at the present time, and have handed the same to the president.

ASAPH HALL.
LEWIS BOSS.
SETH C. CHANDLER.

The PRESIDENT OF THE NATIONAL ACADEMY:

In accordance with the vote of the Academy, April 19, 1899, the directors of the Benjamin Apthorp Gould fund herewith respectfully submit a report of progress on such work as they have encouraged, so far as it is practicable to make such a report at the present time:

Appropriation No. 1, to Doolittle, $500, of date 1899, March 28.

A computer was at work during the greater part of the year ending July 1, 1900. Although not completed at that time the final reduction was so far advanced that the first instalment of the work at Bethlehem on the variation of latitude and aberration was soon ready for the printer, and is now in process of publication by the American Philosophical Society of Philadelphia. It is hoped that the remainder will be in shape during the current summer and printed about one year from the present date.

Appropriation No. 2, to Mr. Henry M. Parkhurst, $300, of date 1899, March 25.

About two-thirds of the sum advanced was used for reconstruction of observatory and instruments and the remainder in instrumental improvements. The work done in the observations of variable stars has been printed in five communications to the

Astronomical Journal, and the continuation to date is nearly ready for printing. It is to be indefinitely continued in the future.

Besides this the work on the photometric observation of the asteroids has been continuously prosecuted to date, and especially those relating to Eros, which series already covers more than six months, and is ready for publication.

Appropriation No. 3, to John A. Parkhurst, $30, of date 1900, April 18.

Money expended in purchase of the first two parts of Hagen's Atlas of Variable Stars, to be used in conjunction with the 40-inch refractor of the Yerkes Observatory, Chicago, for the observation of the minima of the fainter variables. A specific account of the progress of this work has not yet been called for by the board.

Appropriation No. 4, to Dr. Herman S. Davis, $500, of date 1900, April 18.

A detailed report of the work done to date has been received by the board. The money has been used for the computation of the refractions and the reductions to apparent place, and enough of the appropriation is in hand to complete the computation of the refractions.

Appropriations Nos. 5 and 6 being quite recent, the board deems it too early to make a specific report with regard to them.

ASAPH HALL.
LEWIS BOSS.
SETH C. CHANDLER.

REPORT OF THE COMMITTEE ON THE WOLCOTT GIBBS FUND.

CAMBRIDGE, *April 9, 1901.*

DEAR SIR: I have the honor to report that the committee on the Wolcott Gibbs fund voted, when it was established, that the income of the fund should be paid to Dr. Wolcott Gibbs during his life.

Very respectfully,

C. L. JACKSON, *Chairman.*

The PRESIDENT OF THE NATIONAL ACADEMY.

ELECTIONS.

ELECTION OF OFFICERS.

Mr. Alexander Agassiz was elected president of the Academy, Mr. Ira Remsen, foreign secretary, and Mr. Arnold Hague, home secretary, for the ensuing term of six years.

Messrs. Billings, Bowditch, Brush, Hague, Langley, and Newcomb were elected members of the council.

Mr. S. P. Langley resigned.

ELECTION OF MEMBERS.

Messrs. George F. Becker, James McK. Cattell, Eliakim H. Moore, Edward L. Nichols, and T. Mitchell Prudden were elected members of the Academy.

ELECTION OF FOREIGN ASSOCIATES.

The following gentlemen were elected foreign associates: Eduard Bornet, Paris; Alfred Cornu, Paris; Sir Archibald Geikie, London; J. H. van't Hoff, Berlin; J. Janssen, Paris; Friedrich Kohlrausch, Berlin; Hugo Kronecker, Bern; Maurice Loewy, Paris.

DEATHS.

During the year 1901 the Academy lost by death five members and one foreign associate. Mr. Henry A. Rowland died on the 16th of April; Joseph Le Conte, July 6; Charles A. Schott, July 31; Richmond Mayo-Smith, November 11, and Clarence King, December 24. Mr. Henri de Lacaze-Duthiers, foreign associate, died July 21.

LIST OF PAPERS PRESENTED AT THE SCIENTIFIC SESSION.

The Use of Formulæ in Demonstrating the Relations of the Life History of an Individual to the Evolution of its Group. Alpheus Hyatt.

Artificial Parthenogenesis and its Relation to Normal Fertilization. E. B. Wilson.

Simultaneous Volumetric and Electric Graduation of the Condensation Tube. Carl Barus.

The Climatology of the Isthmus of Panama. Henry L. Abbot.

The Effects of Secular Cooling and Meteoric Dust on the Length of the Terrestrial Day. R. S. Woodward.

Table of Results of an Experimental Enquiry regarding the Nutritive Action of Alcohol, prepared by Prof. W. O. Atwater, of Middletown, Conn. Presented by J. S. Billings.

The Place of Mind in Nature. J. W. Powell.

The Significance of the Dissimilar Limbs of the Ornithopodous Dinosaurs. Theo. Gill.

The Foundation of Mind. J. W. Powell.

Conditions Affecting the Fertility of Sheep and the Sex of Their Offspring. Alexander Graham Bell.

The New Spectrum. S. P. Langley.

AUTUMN MEETING, PHILADELPHIA.

SCIENTIFIC SESSION.

A scientific session for the reading of papers having been called by the council, the academy met at Houston Hall, University of Pennsylvania, November 12–14. The foreign secretary, Mr. Ira Remsen, was chosen president pro tem.

The following members were present during the session: Messrs. Barker, Barus, Becker, Beecher, Billings, Boas, Bowditch, Brewer,

Brush, Cattell, Chandler (C. F.), Chittenden, Comstock (C. B.), Crafts, Gill, Hague, Mitchell (S. W.), Morse, Nichols, Osborn, Peirce, Penfield, Remsen, Sellers, Smith (E. F.), Verrill, Welch.

The following papers were presented:

Biographical Memoir of Frederick Augustus Genth. George F. Barker.

Observations on Tungsten. Edgar F. Smith.

A New Gauge for the Direct Measurement of Small Pressures. Edward W. Morley and Charles F. Brush.

On the Logic of Research into Ancient History. Charles S. Peirce.

On the Vaso-motor Supply of the Lungs. Horatio C. Wood, jr. (Introduced by George F. Barker.)

On the use of the Stereographic Projection in Making Accurate Maps; with Criticism of some Recent Methods of Map Projection. Samuel L. Penfield.

Biographical Memoir of General John Newton. Cyrus B. Comstock.

Dolichocephaly and Brachycephaly as the Dominant Factors in Cranial Evolution. Henry F. Osborn.

Latent or Potential Homology. Henry F. Osborn.

Transmission of Heat through Vapor of Water at Small Pressures. Edward W. Morley and Charles F. Brush.

The Monatomic Gases. George F. Barker.

On the Pseudo-catalytic Action of Concentrated Acids. James M. Crafts.

Snake Venom in Relation to Hæmolysis, Bacteriolysis, and Toxicity. S. Weir Mitchell and Simon Flexner.

Note on Linear Force exerted by Growing Crystals. George F. Becker.

Note on the Orogenic Theory of Tilted Blocks. George F. Becker.

Cranial Evolution of Titanotherium II. Henry F. Osborn.

On Quadrant Electrometry with a Free Light Needle Highly Charged through a Conductor of Ionized Air. Carl Barus.

On Nuclear Condensation in the Vapor of Non-Electrolytes like Benzene; and on Graded Condensation. Carl Barus.

The Work of the International Association of Academies. Henry P. Bowditch.

A Method of Rearing Marine Larvæ. Caswell Grave. (Introduced by William K. Brooks.)

On the Newer Forms of Incandescent Electric Lamps. George F. Barker.

BUSINESS MEETING OF THE ACADEMY.

A business meeting of the academy, called by the council to consider the report of the president to Congress and such other business as might be presented, was held November 13, Mr. Ira Remsen, the *foreign secretary*, presiding.

The recommendation of the council that the president be authorized to include in his annual report to Congress the proceedings of the present meeting, as well as those of the meeting at Washington in April, 1901, and also any matters relating to government business that may be submitted to the academy prior to the presentation of his report, was approved.

The following announcements were made:

The academy was represented by W. G. Farlow, of Cambridge, at the meeting of the International Association of Botanists that met at Geneva August last.

Ira Remsen was appointed a delegate to represent the National Academy of Sciences at the bicentennial celebration of Yale University in October, 1901.

The president of the academy has appointed Edward S. Morse a member of the general committee on the International Congress of Americanists which will be held in New York in 1902.

Letters have been received from Messrs. Cornu, Sir Archibald Geikie, and M. Janssen, accepting foreign membership in the academy.

THE INTERNATIONAL ASSOCIATION OF ACADEMIES.

The International Association of Academies held its first general meeting in Paris in 1901. The eighteen academies which make up the International Association would all have been represented at the meeting had it not been that the delegate of the National Academy of Sciences, Prof. George L. Goodale, was prevented from being present by the condition of his health.

The amendments to Section X of the proposed statutes of the International Association of Academies proposed by the National Academy of Sciences, and seconded by the Royal Society of London, were adopted. The amendments are given below:

Such special committees shall consist of delegates appointed by the constituent academies with special reference to their qualification to deal with the questions under consideration.

The first meeting of such a committee shall be called by the president of the International Association or by the president of the council, and at this meeting each committee shall adopt rules for its own guidance.

Each special committee shall make a report embodying such recommendations as it may think advisable, to the president of the International Council, who shall transmit the same to the constituent academies.

The president of the council shall, however, have power if he see fit, before submitting such reports to the constituent academies, to submit the same to the council, and this body shall have power to refer back the report to the committee for further consideration.

It was decided to hold a general meeting in 1904.

Among the questions brought up for discussion were the following:

1. A plan for the mutual loaning of manuscripts, proposed by the Academy of Sciences of Berlin.

2. A study of the proper means of preparing and publishing a complete edition of the works of Leibnitz. This was presented by the Academy of Moral and Political Sciences of the Institute of France.

3. The Royal Society of London presented a report on the question of the extension of the geodetic arc along the thirtieth meridian.

4. On behalf of the Academy of Sciences of Berlin, M. Marey presented a report on a plan for the supervision of physiological instruments.

5. The Royal Saxon Society suggested the appointment of an expert committee on human and comparative embryology, and on the anatomy of the brain.

6. A communication was presented from the Royal Society of London concerning an International Catalogue of Scientific Literature of which this society has the direction.

A full report of the proceedings of the meeting has been published, and copies can be obtained through the foreign secretary of the Academy.

APPENDICES.

APPENDIX A.

CONSTITUTION AND RULES OF THE NATIONAL ACADEMY OF SCIENCES.

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895; April 20, 1899.

PREAMBLE.

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS.

SEC. 1. The Academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the sessions of the Academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the Academy.

SEC. 3. The Academy may elect fifty foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings and of reading and communicating papers to the Academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the Academy.

ARTICLE II.—OF THE OFFICERS.

SEC. 1. The officers of the Academy shall be a president, a vice-president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated session after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the session when such vacancy occurs, or at the next stated session thereafter, as the Academy may direct. A vacancy in the office of treasurer or home secretary may,

however, be filled by appointment of the president of the Academy until the next stated session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the Academy.

SEC. 3. The president of the Academy, or in case of his absence or inability to act the vice-president, shall preside at the meetings of the Academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects and report thereon to the Academy at its sessions next ensuing; and, with the council, shall direct the general business of the Academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments not members of the Academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the Academy at one of the stated sessions in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each session shall be duly engrossed before the next stated session, under the direction of the home secretary.

SEC. 5. The treasurer shall attend to all receipts and disbursements of the Academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the April session. He shall be the custodian of the corporate seal of the Academy.

ARTICLE III.—OF THE MEETINGS.

SEC. 1. The Academy shall hold one stated session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions of the Academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Scientific sessions of the Academy may be held at times and places to be designated by a majority of the council.

SEC. 2. The names of the members present at each daily meeting *shall be* recorded in the minutes, and the members present at any *meeting shall* constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special sessions may be convened at the call of the president and two members of the council, or of four members of the council.

SEC. 5. No member who has not paid his dues shall take part in the business of the Academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS.

SEC. 1. All elections shall be by ballot, and each election shall be held separately unless otherwise ordered by this constitution.

SEC. 2. The time for holding an election of officers shall be fixed by the Academy at least one day before the election is held.

SEC. 3. The six additional members of the council shall be elected, on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. The Academy shall be divided into six standing committees. In this classification a member who is eminent in more than one subject may be assigned to a corresponding number of committees. The classification shall be the following:

1. Mathematics and Astronomy.
2. Physics and Engineering.
3. Chemistry.
4. Geology and Paleontology.
5. Biology.
6. Anthropology.

In nominating for membership in the Academy, a statement must be made as to the subject or subjects in which the person nominated is eminent. Every nomination must be submitted, through the secretary, to all the members of the committee or committees representing the

subject or subjects in which the person nominated is stated to be eminent; and in order that his name may be brought before the Academy for election he must receive the votes of a majority of the members of the committee or committees to which his name has been referred.

Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot the members present may proceed to elect new members in the following manner: At each ballot each member present may vote for not exceeding three persons, and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be declared to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

Before and during elections a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated session after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. Foreign associates may be nominated by a committee of five members, to be appointed for that purpose by the president and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

SEC. 8. A diploma, with the corporate seal of the Academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership, and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the Academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the Academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the Academy and his name shall be dropped from the roll.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS.

SEC. 1. Communications on scientific subjects shall be read at scientific meetings of the Academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the Academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the president, with the advice of the council.

SEC. 3. The Academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the Academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained, and to the Academy at its next following stated session.

SEC. 5. The advice of the Academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council, and afterwards to the Academy, at one of the stated sessions.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the Academy, upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the Academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY.

SEC. 1. All investments shall be made by the treasurer, in the corporate name of the Academy, in stocks of the United States, or, with

the approval of the council, in State bonds or first-mortgage bonds on real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds held by him in the corporate name of the Academy.

SEC. 2. No contract shall be binding upon the Academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the Academy shall be fixed by the Academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS.

Additions and amendments to the constitution shall be made only at a stated session of the Academy. Notice of a proposition for such a change must be given at a stated session, and shall be referred to the council, which may amend the proposition, and shall report thereon to the Academy at the same session. Its report shall be considered by the Academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated session, and if it receive two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

APPENDIX B.

RULES.

I. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of viva voce votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected, by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented, which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year and referred with the accounts to the auditing committee.

IV. A committee of arrangements, consisting of five members, shall be appointed by the president for each stated session of the Academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members, to arrange the business of each day, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to ascertain the length of time required for reading the several memoirs presented and, when it appears advisable, to recommend a limit of time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice-president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.

7. Other business.

8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the Academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the Academy, the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business.

VIII. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session; but no memoir shall be published unless it has been read before the Academy.

X. Memoirs shall date, in the records of the Academy, from the date of their presentation to the Academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

XI. Papers from persons not members read before the Academy and intended for publication shall be referred at the meeting at which they are read to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the Academy as early as practicable, and not later than the next stated session.

XII. The annual report of the Academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XIII. The proper secretary shall acknowledge all donations made to the Academy, and shall report them at the next stated session.

XIV. The books, apparatus, archives, and other collections of the Academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XV. A stamp corresponding to the corporate seal of the Academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVI. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of Departments of the Govern-

ment, and in each case to look to the Department requesting the investigation for reimbursement to the Academy.

XVII. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XVIII. At least sixty days before the election the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XIX. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XX. All discussions as to the claims and qualifications of nominees at meetings of the Academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the Academy at the time of the discussion.

XXI. Any rule of the Academy may be amended, suspended, or repealed, on the written motion of any two members, signed by them, and presented at a stated session of the Academy, provided the same shall be approved by a majority of the members present.

By a resolution adopted January 12, 1864, the president is ex officio a member of all government committees of the Academy.

APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1901-1902.

	Expiration of term.
AGASSIZ, ALEXANDER, *President*	April, 1907.
HALL, ASAPH, *Vice-President*	April, 1903.
REMSEN, IRA, *Foreign Secretary*	April, 1907.
HAGUE, ARNOLD, *Home Secretary*	April, 1907.
WALCOTT, CHARLES D., *Treasurer*	April, 1904.

ADDITIONAL MEMBERS OF COUNCIL, 1901-1902.

BILLINGS, J. S.
BOWDITCH, H. P.
BRUSH, G. J.
NEWCOMB, S.

COMMITTEES OF THE ACADEMY.

On nominations of new members.

1. Mathematics and Astronomy.
   - ABBE, C.
   - BOSS, L.
   - CHANDLER, S. C.
   - COMSTOCK, G. C.
   - DAVIDSON, G.
   - ELKIN, W. L.
   - HALL, A.
   - HILL, G. W.
   - HOLDEN, E. S.
   - LANGLEY, S. P.
   - MOORE, E. H.
   - NEWCOMB, S.
   - PEIRCE, C. S.
   - PICKERING, E. C.
   - WOODWARD, R. S.
   - YOUNG, C. A.
2. Physics and Engineering.
   - ABBE, C.
   - ABBOT, H. L.
   - BARKER, G. F.
   - BARUS, C.
   - BELL, A. G.
   - COMSTOCK, C. B.
   - GIBBS, J. W.
   - HASTINGS, C. S.
   - LANGLEY, S. P.
   - MENDENHALL, T. C.
2. Physics and Engineering—Continued.
   - MICHELSON, A. A.
   - MITCHELL, H.
   - MORLEY, E. W.
   - MORTON, H.
   - NICHOLS, E. L.
   - PICKERING, E. C.
   - ROOD, O. N.
   - SELLERS, W.
   - TROWBRIDGE, J.
   - WOODWARD, R. S.
   - WRIGHT, A. W.
3. Chemistry.
   - BARKER, G. F.
   - BRUSH, G. J.
   - CHANDLER, C. F.
   - CHITTENDEN, R. H.
   - CRAFTS, J. M.
   - DANA, E. S.
   - GIBBS, W.
   - GOOCH, F. A.
   - HILGARD, E. W.
   - HILL, H. B.
   - JACKSON, C. L.
   - JOHNSON, S. W.
   - MICHAEL, A.
   - MORLEY, E. W.
   - PENFIELD, S. L.

3. Chemistry—Continued.
   - REMSEN, I.
   - RICHARDS, T. W.
   - SMITH, E. F.

4. Geology and Paleontology.
   - BECKER, G. F.
   - BEECHER, C. E.
   - DALL, W. H.
   - DUTTON, C. E.
   - EMMONS, S. F.
   - GILBERT, G. K.
   - HAGUE, ARNOLD.
   - LESLIE, J. P.
   - OSBORN, H. F.
   - PACKARD, A. S.
   - PUMPELLY, R.
   - WALCOTT, C. D.
   - WHITE, C. A.

5. Biology.
   - AGASSIZ, A.
   - ALLEN, J. A.
   - BOWDITCH, H. P.
   - BREWER, W. H.
   - BROOKS, W. K.
   - CHITTENDEN, R. H.
   - DALL, W. H.
   - FARLOW, W. G.
   - GILL, T. N.

5. Biology—Continued.
   - GOODALE, G. L.
   - MINOT, C. S.
   - MORSE, E. S.
   - OSBORN, H. F.
   - PACKARD, A. S.
   - PRUDDEN, T. M.
   - PUTNAM, F. W.
   - SARGENT, C. S.
   - SCUDDER, S. H.
   - SMITH, S. I.
   - VERRILL, A. E.
   - WALCOTT, C. D.
   - WELCH, W. H.
   - WHITE, C. A.
   - WHITMAN, C. O.
   - WILSON, E. B.
   - WOOD, H. C.

6. Anthropology.
   - BILLINGS, J. S.
   - BOAS, F.
   - CATTELL, J. McK.
   - MINOT, C. S.
   - MITCHELL, S. W.
   - MORSE, E. S.
   - POWELL, J. W.
   - PUTNAM, F. W.
   - WELCH, W. H.

Executive Committee.

WALCOTT, C. D.
NEWCOMB, S.
AGASSIZ, A., ex officio.
HAGUE, ARNOLD, ex officio.
LANGLEY, S. P.

On Weights, Measures, and Coinage.

MENDENHALL, T. C., *Chairman.*
MICHELSON, A. A.
NEWCOMB, S.
PEIRCE, C. S.
YOUNG, C. A.

On the Election of Foreign Associates.

REMSEN, IRA, *Chairman.*
HALL, A.
MITCHELL, S. W.
NEWCOMB, S.

On Publications of the Academy.

GILL, T. N.

TRUST FUNDS.

Board of Direction of the Bache Fund.

GIBBS, WOLCOTT, *Chairman.*
CHANDLER, S. C.
SCUDDER, S. H.

Board of Trustees of the Watson Fund.

NEWCOMB, S., *Chairman.*
HALL, A.
BOSS, L.

The Henry Draper Fund.

PICKERING, E. C., *Chairman.* TROWBRIDGE, J.
NEWCOMB, S. WRIGHT, A. W.
MICHELSON, A. A.

The J. Lawrence Smith Fund.

BRUSH, G. J., *Chairman.* JOHNSON, S. W.
MORLEY, E. W. PUMPELLY, R.
REMSEN, IRA.

The Benjamin Apthorp Gould Fund.

HALL, ASAPH, *Chairman.* CHANDLER, S. C.
BOSS, LEWIS.

The Barnard Medal.

BILLINGS, J. S., *Chairman.* ROOD, O. N.
BOWDITCH, H. P. JACKSON, C. L.
CHANDLER, S. C. NEWCOMB, S.

The Wolcott Gibbs Fund.

JACKSON, C. L., *Chairman.* REMSEN, IRA.
DROWN, T. M.

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, JANUARY 20, 1902.

		Date of election.
ABBE, CLEVELAND	*2017 I st. NW., Washington, D. C.*	1879
ABBOT, HENRY L., U. S. A	*23 Berkeley st., Cambridge, Mass.*	1872
AGASSIZ, ALEXANDER	*Cambridge, Mass.*	1866
ALLEN, J. ASAPH	*American Museum, New York City.*	1876
BARKER, GEORGE F	*3909 Locust st., Philadelphia, Pa.*	1876
BARUS, CARL	*Providence, R. I.*	1892
BECKER, GEORGE F	*U. S. Geological Survey, Washington, D. C.*	1901
BEECHER, CHARLES E	*New Haven, Conn.*	1899
BELL, A. GRAHAM	*1331 Connecticut ave., Washington, D. C.*	1883
BILLINGS, JOHN S., U. S. A	*32 E. Thirty-first st., New York City.*	1883
BOAS, FRANZ	*123 W. Eighty-second st., New York City.*	1900
BOSS, LEWIS	*Albany, N. Y.*	1889
BOWDITCH, HENRY P	*Jamaica Plain, Mass.*	1887
BREWER, WILLIAM H	*418 Orange st., New Haven, Conn.*	1880
BROOKS, W. K	*Johns Hopkins University, Baltimore, Md.*	1884
BRUSH, GEORGE J	*14 Trumbull st., New Haven, Conn.*	1868
CATTELL, JAMES MCK	*Columbia University, New York City.*	1901
CHANDLER, CHARLES F	*Columbia University, New York City.*	1874
CHANDLER, SETH C	*16 Craigie st., Cambridge, Mass.*	1888
CHITTENDEN, RUSSELL H	*New Haven, Conn.*	1890
COMSTOCK, CYRUS B., U. S. A	*34 W. Twenty-fifth st., New York City.*	1884
COMSTOCK, GEORGE C	*Washburn Observatory, Madison, Wis.*	1899
CRAFTS, JAMES M	*59 Marlboro st., Boston, Mass.*	1872
DALL, WILLIAM H	*Washington, D. C.*	1897
DANA, EDWARD S	*New Haven, Conn.*	1884
DAVIDSON, GEORGE	*2221 Washington st., San Francisco, Cal.*	1874
DUTTON, CLARENCE E., U. S. A	*Washington, D. C.*	1884
ELKIN, WILLIAM L	*New Haven, Conn.*	1895
EMMONS, SAMUEL F	*Washington, D. C.*	1892
FARLOW, W. G	*Cambridge, Mass.*	1879

		Date of election.
GIBBS, JOSIAH WILLARD	*New Haven, Conn.*	1879
GIBBS, WOLCOTT	*Newport, R. I.*	——
GILBERT, GROVE K	*Washington, D. C.*	1883
GILL, THEODORE N	*Washington, D. C.*	1873
GOOCH, FRANK A	*New Haven, Conn.*	1897
GOODALE, GEORGE L	*Cambridge, Mass.*	1890
HAGUE, ARNOLD	*U. S. Geological Survey, Washington, D. C.*	1885
HALL, ASAPH	*South Norfolk, Conn.*	1875
HASTINGS, CHARLES S	*New Haven, Conn.*	1889
HILGARD, EUGENE W	*Berkeley, Cal.*	1872
HILL, GEORGE W	*West Nyack, N. Y.*	1874
HILL, HENRY B	*Cambridge, Mass.*	1883
HOLDEN, EDWARD S	*U. S. Military Academy, West Point, N. Y.*	1885
JACKSON, CHARLES L	*6 Boylston Hall, Cambridge, Mass.*	1883
JOHNSON, SAMUEL W	*54 Trumbull st., New Haven, Conn.*	1866
LANGLEY, SAMUEL P	*Washington, D. C.*	1876
LESLEY, J. PETER	*Milton, Mass.*	——
MENDENHALL, THOMAS C	*Worcester, Mass.*	1887
MICHAEL, ARTHUR	*Tufts College, Mass.*	1889
MICHELSON, ALBERT A	*Chicago, Ill.*	1888
MINOT, CHARLES S	*Boston, Mass.*	1897
MITCHELL, HENRY	*Nantucket, Mass.*	1885
MITCHELL, S. WEIR	*1524 Walnut st., Philadelphia, Pa.*	1865
MOORE, ELIAKIM H	*University of Chicago, Chicago, Ill.*	1901
MORLEY, EDWARD W	*2238 Euclid ave., Cleveland, Ohio.*	1897
MORSE, EDWARD S	*P. O. Box 268, Salem, Mass.*	1876
MORTON, HENRY	*Hoboken, N. J.*	1874
NEWCOMB, SIMON, U. S. N	*1620 P st. NW., Washington, D. C.*	1869
NICHOLS, EDWARD L	*Cornell University, Ithaca, N. Y.*	1901
OSBORN, H. F	*American Museum of Natural History, New York City.*	1900
PACKARD, A. S	*275 Angell st., Providence, R. I.*	1872
PEIRCE, CHARLES S	*Milford, Pa.*	1876
PENFIELD, S. L	*New Haven, Conn.*	1900
PICKERING, EDWARD C	*Cambridge, Mass.*	1873
POWELL, JOHN W	*Washington, D. C.*	1880
PRUDDEN, T. MITCHELL	*Columbia University, New York City.*	1901
PUMPELLY, RAPHAEL	*Gibbs ave., Newport, R. I.*	1872
PUTNAM, FREDERICK W	*Peabody Museum, Cambridge, Mass.*	1885
REMSEN, IRA	*Johns Hopkins University, Baltimore, Md.*	1882
RICHARDS, THEODORE W	*Cambridge, Mass.*	1899
ROOD, OGDEN N	*New York City.*	1865
SARGENT, CHARLES S	*Jamaica Plain, Mass.*	1895
SCUDDER, SAMUEL H	*Cambridge, Mass.*	1877
SELLERS, WILLIAM	*1819 Vine st., Philadelphia, Pa.*	1873
SMITH, EDGAR F	*Philadelphia, Pa.*	1899
SMITH, SIDNEY I	*New Haven, Conn.*	1884
TROWBRIDGE, JOHN	*Cambridge, Mass.*	1878
VERRILL, A. E	*New Haven, Conn.*	1872
WALCOTT, CHARLES D	*Washington, D. C.*	1896
WELCH, WILLIAM H	*935 St. Paul st., Baltimore, Md.*	1895
WHITE, CHARLES A	*330 T st. NW., Washington, D. C.*	1889
WHITMAN, CHARLES O	*University of Chicago, Chicago, Ill.*	1895
WILSON, EDMUND B	*Columbia University, New York City.*	1899

		Date of election.
WOOD, HORATIO C	*1925 Chestnut st., Philadelphia, Pa.*	1879
WOODWARD, ROBERT S	*Columbia University, New York City.*	1896
WRIGHT, ARTHUR W	*New Haven, Conn.*	1881
YOUNG, CHARLES A	*Princeton, N. J.*	1872

DECEASED MEMBERS.

	Date of death.
*AGASSIZ, LOUIS	Dec. 14, 1873
*ALEXANDER, J. H	Mar. 2, 1867
*ALEXANDER, STEPHEN	June 25, 1883
*BACHE, ALEXANDER DALLAS	Feb. 14, 1867
*BAIRD, SPENCER F	Aug. 19, 1887
BARNARD, F. A. P	Apr. 27, 1889
BARNARD, J. G	May 14, 1882
BARTLETT, W. H. C	Feb. 11, 1893
*BROWN-SEQUARD, CHARLES E	Apr. 2, 1894
*CASEY, THOMAS L	Mar. 25, 1896
*CASWELL, ALEXIS	Jan. 8, 1887
*CHAUVENET, WILLIAM	Dec. 13, 1870
*CLARKE, HENRY JAMES	July 1, 1873
*COFFIN, JAMES H	Jan. 6, 1873
*COFFIN, J. H. C	Jan. 8, 1890
*COOK, GEORGE H	Sept. 22, 1889
*COOKE, JOSIAH P	Sept. 3, 1894
*COPE, EDWARD D	Apr. 12, 1897
COUES, ELLIOTT	Dec. 25, 1899
DALTON, J. C	Feb. 2, 1889
DANA, JAMES D	Apr. 14, 1895
*DAVIS, CHARLES H	Feb. 18, 1877
*DRAPER, HENRY	Nov. 20, 1882
*DRAPER, JOHN W	Jan. 4, 1882
*EADS, JAMES B	Mar. 8, 1887
*ENGELMAN, GEORGE	Feb. 4, 1884
*FERREL, WILLIAM	Sept. 18, 1891
*FRAZER, JOHN FRIES	Oct. 12, 1872
*GABB, WILLIAM M	May 30, 1878
*GENTH, F. A	Feb. 2, 1893
*GILLISS, JAMES MELVILLE	Feb. 9, 1865
*GOODE, G. BROWN	Sept. 6, 1896
*GOULD, AUGUSTUS A	Sept. 15, 1866
GOULD, BENJAMIN A	Nov. 27, 1896
*GRAY, ASA	Jan. 30, 1888
*GUYOT, ARNOLD	Feb. 8, 1884
*HADLEY, JAMES	Aug. 1, 1864
*HALDEMAN, S. S	Sept. 20, 1880
HALL, JAMES	Aug. 8, 1898
*HAYDEN, F. V	Dec. 22, 1887
*HENRY, Joseph	May 13, 1878
*HILGARD, JULIUS E	May 8, 1891
*HITCHCOCK, EDWARD	Feb. 27, 1864
*HOLBROOK, J. E	Sept. 8, 1871

*Biographical notices have been presented of those designated by an asterisk.

	Date of death.
*Hubbard, J. S	Aug. 16, 1863
*Humphreys, A. A	Nov. 28, 1883
Hunt, T. Sterry	Feb. 12, 1892
Hyatt, Alpheus	Jan. 16, 1902
Keeler, J. E	Aug. 12, 1900
King, Clarence	Dec. 24, 1901
*Kirkland, Jared P	Dec. 10, 1877
*Lane, J. Homer	May 3, 1880
*Le Conte, John	Apr. 29, 1891
*Le Conte, John L	Nov. 15, 1883
Le Conte, Joseph	July 6, 1901
Lea, Matthew C	Mar. 15, 1897
Leidy, Joseph	Apr. 30, 1891
*Lesquereux, Leo	Oct. 25, 1889
Longstreth, Miers F	Dec. 27, 1891
*Loomis, Elias	Aug. 16, 1889
Lovering, Joseph	Jan. 18, 1892
Lyman, Theodore	Sept. 10, 1897
*Mahan, D. H	Sept. 16, 1871
*Marsh, G. P	July 23, 1882
Marsh, O. C	Mar. 18, 1899
Mayer, Alfred M	July 13, 1897
Mayo-Smith, Richmond	Nov. 11, 1901
*Meek, F. B	Dec. 21, 1877
*Meigs, M. C	Jan. 2, 1892
*Morgan, Lewis H	Dec. 14, 1881
Newberry, J. S	Dec. 7, 1892
*Newton, H. A	Aug. 1, 1896
*Newton, John	May 1, 1895
*Norton, William A	Sept. 21, 1883
*Oliver, James E	Mar. 27, 1895
Peters, C. H. F	July 18, 1890
*Pourtales, L. F	July 19, 1880
Rodgers, John	May 5, 1882
Rogers, Fairman	Aug. 23, 1900
Rogers, Robert E	Sept. 7, 1884
*Rogers, Wm. A	Mar. 1, 1898
*Rogers, William B	May 30, 1882
Rowland, Henry A	Apr. 16, 1901
*Rutherfurd, Lewis M	May 30, 1892
*Saxton, Joseph	Oct. 26, 1873
Schott, Charles A	July 31, 1901
*Silliman, Benj., Sr	Nov. 24, 1864
Silliman, Benj., Jr	Jan. 14, 1885
*Smith, J. Lawrence	Oct. 12, 1883
*Stimpson, William	May 26, 1873
*Strong, Theodore	Feb. 1, 1869
*Sullivant, W. S	Apr. 30, 1873
*Torrey, John	Mar. 10, 1873
*Totten, J. G	Apr. 22, 1864
*Trowbridge, William P	Aug. 12, 1892

*Biographical notices have been presented of those designated by an asterisk.

	Date of death.
TRUMBULL, JAMES H	Aug. 5, 1897
*TUCKERMAN, EDWARD	Mar. 15, 1886
WALKER, FRANCIS A	Jan. 5, 1897
*WARREN, G. K	Aug. 8, 1882
*WATSON, JAMES C	Nov. 23, 1880
*WATSON, SERENO	Mar. 9, 1892
*WINLOCK, JOSEPH	June 11, 1875
*WOODWARD, J. J	Aug. 17, 1884
*WORTHEN, A. H	May 6, 1888
*WYMAN, JEFFRIES	Sept. 4, 1874

FOREIGN ASSOCIATES.

AUWERS, ARTHUR	*Berlin.*
BAEYER, ADOLPH (RITTER VON)	*Munich.*
BERTHELOT, M. P. E	*Paris.*
BORNET, EDOUARD	*Paris.*
CORNU, ALFRED	*Paris.*
GEGENBAUR, KARL	*Heidelberg.*
GEIKIE, Sir ARCHIBALD	*London.*
GILL, DAVID	*Cape Town.*
HOFF, J. H. VAN'T	*Berlin.*
HOOKER, Sir J. D	*London.*
JANSSEN, J	*Paris.*
KELVIN (Lord)	*London.*
KLEIN, FELIX	*Göttingen.*
KOHLRAUSCH, FRIEDRICH	*Berlin.*
KÖLLIKER, ALBERT VON	*Würzburg.*
KRONECKER, HUGO	*Bern.*
LISTER (Lord)	*London.*
LOEWY, MAURICE	*Paris.*
MOISSAN, HENRI	*Paris.*
POINCARÉ, HENRI	*Paris.*
RAYLEIGH (Lord)	*London.*
RICHTHOFEN, F. VON	*Berlin.*
STOKES, Sir GEORGE G	*Cambridge.*
STRASBURGER, EDOUARD	*Bonn.*
STRUVE, OTTO VON	*Karlsruhe.*
SUESS, EDOUARD	*Vienna.*
VIRCHOW, RUDOLPH VON	*Berlin.*
ZITTEL, KARL ALFRED (RITTER VON)	*Munich.*

*Biographical notices have been presented of those designated by an asterisk.

DECEASED FOREIGN ASSOCIATES.

Sir Wm. Rowan Hamilton.
Karl Ernst von Baer.
Henry Milne-Edwards.
Michael Faraday.
L. Elie de Beaumont.
Sir David Brewster.
G. A. A. Plana.
F. W. A. Argelander.
Friedrich Wöhler.
J. B. Dumas.
J. B. J. D. Boussingault.
M. E. Chevreul.
Michel Chasles.
Sir George B. Airy.
J. C. Adams.
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